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ERRATA

Page 38, article by Tapke, last line, instead of "controls loose smut of wheat reducing yields" read "controls loose smut of wheat without reducing yields."

Page 55, second abstract title change "tubes" to "tubers."

Page 56, first abstract title "J. I. Jauritzen" should read J. L. Lauritzen.

Page 99, line 5, instead of "one plant" read "all the descendants of one plant."

February number, table of contents on cover, change pagination as follows: 74 to 75, 85 to 87, 97 to 100, and 100 to 104.

February number, omit "Phytopathological notes 103" on cover.

Page 231, line 10 from bottom, change Actinomycetes to Actinomyces.

July number, table of contents on cover, change authors of sixth article to Charles A. Kofoid, Henry H. P. Severin, and Olive Swezy.

Page 362, name of author, change "B" to "G."

Page 386, line 12, foot note reference number 1 refers to footnote at end of article on page 391.

Page 389, first column of table, first line change "Phythium" to Pythium.

Page 391, (1) Buttner, etc. change "etwas ber" to "etwas über." Footnote should go at foot of page 386.

December number cover. Next to last title in contents, insert "selected" after "isolating."

Page 529, line 19, change "more variable conidia" to "less variable conidia".

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PHYTOPATHOLOGY

VOLUME XIII NUMBER 1

JANUARY, 1923

III. SEPTORIA DISEASE OF RYE, BARLEY AND CERTAIN GRASSES.

GEORGE F. WEBER

WITH NINE FIGURES IN THE TEXT

SEPTORIA LEAF BLOTCH OF RYE[1]

INTRODUCTION

A disease was found on the leaves of rye in the experimental plot at the Hill Farm of the University of Wisconsin. On examination it was found to be caused by *Septoria secalis* Prill. and Del. The leaves were the only part of the rye plant attacked. The lesions were rather irregular in outline ranging from small, almost circular spots to larger areas often involving the whole leaf blade. The center of the spots was yellowish to grayish-white as described by Kirchner (6) in Germany. In many instances the yellow was entirely lacking and large portions of the leaf were grayish-white and thickly speckled with pycnidia. Leaves were found infected from the time of the appearance of growth in the spring until harvest. After blossoming time the infected leaves on the culm showed more bleaching than did the infected leaves earlier in the season. It was reported from different parts of France by Prillieux and Delacroix (9) in 1889, who described it on the leaves of *Secale cereale*. In the United States it has been reported from Virginia, West Virginia, Illinois, and at this time from Wisconsin. It has not been found to be of economic importance in this vicinity even though 100 per cent of plants were infected. It has been reported only on rye.

[1] This is the third and last of three articles by the author on Septoria diseases of cereals and certain grasses. The first appeared in Phytopathology, Number 10, Volume XII, the second in Number 12, Volume XII.

1.P.

CAUSAL ORGANISM

The causal organism was found, described, and named *Septoria secalis* by Prillieux and Delacroix (9) in 1889. The fungus grows readily in culture. The mycelium is hyaline, septate, 1 to 2μ in diameter, branched, and whitish in colonies. The pycnidia are subepidermal, black, globose to subglobose, smooth, 85 to 130μ in diameter. The pycnospores (Fig. 7, E) are hyaline, 3-septate, usually curved, occasionally straight, and rounded at the ends. The content of the pycnospore is homogeneous or slightly guttulate. The pycnospores commonly measure 2.7 by 35μ, extremes 2 to 3.5 by 25 to 49μ. The pycnospores were exuded by soaking the leaf tissue containing pycnidia in water for from ten to fifteen minutes. They were then suspended in water and placed on a potato-dextrose agar culture for germination. Germination tubes were found after from 6 to 8 hours. Transfers were then made to culture tubes. In these tubes abundant mycelium was found but no conidia or perithecia were formed. Pycnospore suspensions obtained in the manner described were used as inoculum and sprayed on a number of rye plants with an atomizer. The plants were immediately placed in a moist chamber for 48 hours and then placed on a greenhouse bench. After two weeks a large number of the leaves showed the disease with pycnidia present. A microscopical examination of the pycnospores showed that they were identical with those collected on rye plants in the field. A large number of cross inoculations were made on other cereals and certain grasses. The summary of these results is shown in table 1 and represented diagramatically in figure 1.

As seen from table 1, and figure 1, *Septoria secalis* was restricted to rye. It would not infect any of the forty species and varieties of cereals and grasses tested, as shown by table 1.

SUMMARY

1. The disease of rye caused by *Septoria secalis* Prill. and Del. has been previously reported only from France. It has been found to occur more or less sparingly in Virginia, West Virginia, Illinois, and Wisconsin.

2. The disease has been found to be of no economic importance.

3. The causal fungus grows readily in artificial culture on potato-dextrose agar.

4. The pycnospores are hyaline, septate, and most commonly measure 2.7 by 35μ.

5. The fungus is pathogenic on the leaves of rye and apparently limited to that host.

SEPTORIA LEAF BLOTCH OF BARLEY

A disease of barley caused by *Septoria passerinii* Sacc. was found in the vicinity of Madison, Wisconsin, in 1920. Leaves of *Hordeum vulgare pallidum* on the Hill Farms of the University of Winconsin were found heavily attacked. The lesions were very indefinite in outline, there

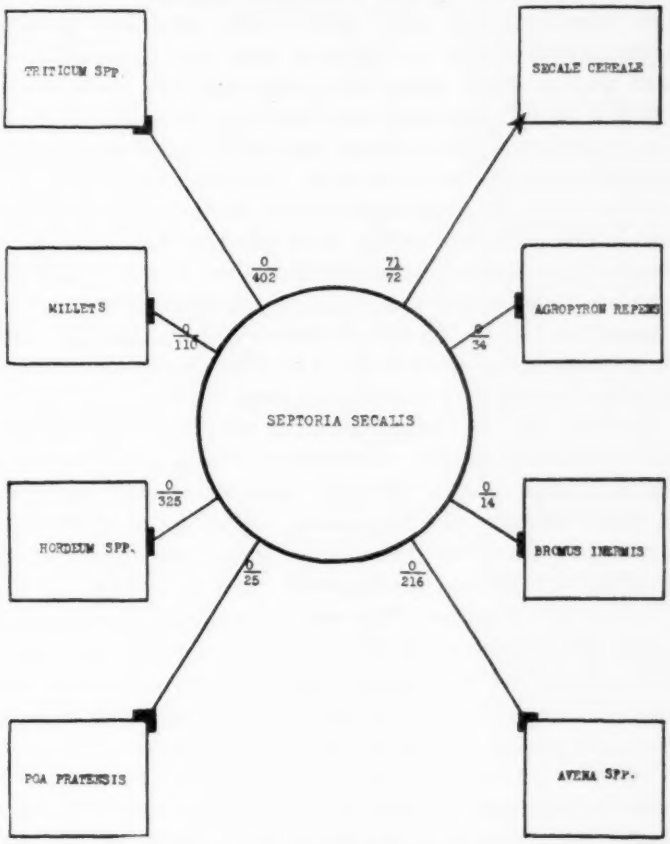

FIG. 1.—Diagram summarizing the results of inoculation experiments with *S. secalis* Plants named in rectangles were inoculated with water suspensions of pycnospores from rye. The denominator and numerator of the fractions designate the number of leaves inoculated and leaves infected respectively. Arrow indicates infection.

being no definite line of demarkation separating the diseased and healthy tissue but rather a gradual blending from the yellowish diseased area to the normal green of the healthy parts of the leaves. Pycnidia were fairly prominent as miniature black specks on the yellow area. They were found also though not always in a mature state in the green tissue

surrounding the yellowish parts. Inoculation experiments were conducted in field plots at the University of Wisconsin and the following symptoms of the disease were produced. The plants appeared normal until about the ninth or tenth day after inoculation at which time rather large, more or less irregular leaf areas began to fade and become yellowish. The color changed rapidly and on approximately the third day after the green color began to fade, small black, speck-like pycnidia were noticeable. After twelve or thirteen days the pycnidia were fairly prominent and in cases where the whole leaf had been inoculated it turned yellow rapidly, drooped and began to die and turn brown. Inoculation experiments out-of-doors especially in the fall, and those in the greenhouse did not produce quite the same symptoms of the disease. In the plots the green color in the lesion appeared to be retained somewhat longer after inoculation than was the case in the greenhouse. The periods of incubation remained the same, however, as the disease was reproduced under both conditions in approximately the same time. In the leaves on the plants out-of-doors the pycnidia were sometimes found in unfaded green areas of the leaf. This disease has been reported from Italy by Passerini (7) in 1879, and from the United States by Johnson (5) in 1916. In 1920 Passerini found the disease on *Hordeum murinum* in the vicinity of Parma. Johnson (5) found it in 1914, 1915, 1917, and 1918 on a large number of species and varieties of barley in North Dakota, South Dakota, and Minnesota. He did not make inoculation experiments and since the pycnospores were very similar to those of *Septoria graminum* Desm. he suggested that they might be the same. In the vicinity of Madison, Wisconsin, the kernels were not affected even though all or nearly all of the leaves were heavily infected.

Passerini (7) named the causal organism *Septoria murina*. Saccardo and Trotter (11) observed the disease on leaves of *Hordeum vulgare* and found that the causal organism was very much like *Septoria murina* Pass. Saccardo (10) in compiling his Sylloge Fungorum found that von Thümen had already described a disease on Iris as *S. murina* and consequently he changed *S. murina* Pass. to *S. passerinii*, by which name the fungus has since been known. This disease was reported in the Plant Disease Survey (8) to occur in the United States, but to be of no economic importance.

Morphology of the Fungus

Mycelium.—In culture, very scant, hyaline, branched, septate, 1–2μ in diameter.

Conidia.—In artificial culture the conidia are cylindrical, straight or slightly curved, rounded at the ends, hyaline, thin walled, 3-septate.

The contents are homogeneous or slightly guttulate. The conidia are indistinguishable from the pycnospores, 1.7 to 3 by 23 to 46μ, averaging 2.3 by 34μ.

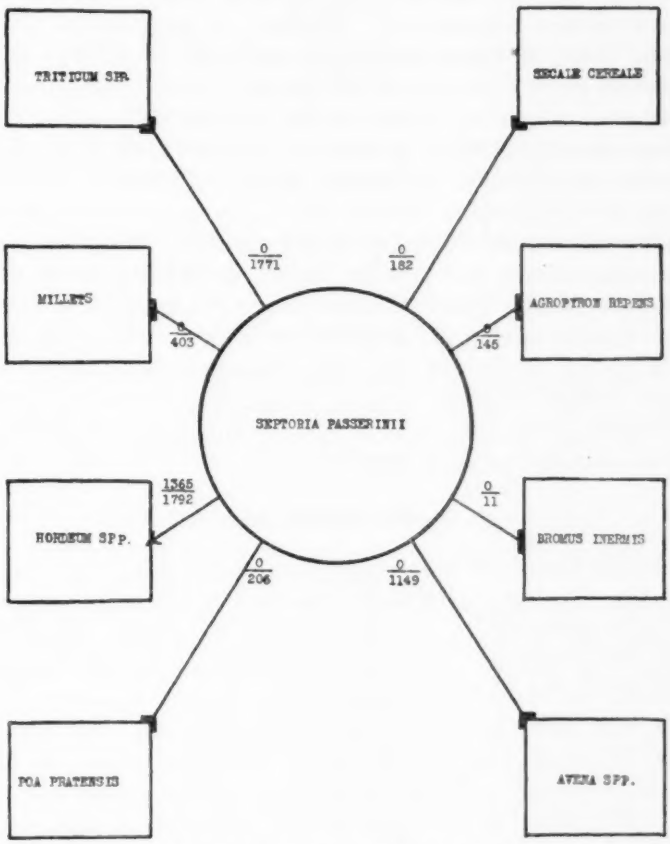

FIG. 2.—Diagram showing the fungus used as inoculum (in the circle), and the groups of host plants (in the rectangles). Denominators show the number of leaves inoculated, the numerators the number of leaves infected.

Pycnidia.—The pycnidia are subepidermal, black, smooth, globose to subglobose, 80 to 150μ in diameter, wall pseudoparenchymatous, 1 to 3 cells thick. The ostiole is oval to elliptical, smooth, under stomata.

Pycnospores.—(Fig. 7, H). Same as conidia. Pycnospores exuded from pycnidium in long, fine, serpentine threads. Very slightly pinkish in mass.

Cultural studies and spore germination.—The pycnospores were secured from the leaves of infected barley plants by soaking pieces of these leaves bearing pycnidia in water for five or ten minutes. The exuded pycnospores suspended in water were used to inoculate solidified potota-dextrose agar poured plates. The medium when solidified in petri dishes was almost transparent. Previous to germination the pycnospores first enlarged, the septations became more prominent and numerous conidia were developed at the septa. These conidia increased in size until they were very similar to the original pycnospore. They in turn germinated by developing other conidia and after 72 hours a small colony was formed, made up almost entirely of conidia. There was a small amount of mycelium within the colony but none on the surface. The colony was raised, smooth, pink and circular. Transfers were made to potato-agar slants, and pinkish, raised, wrinkled growths were subsequently produced. These colonies did not remain pinkish but instead began to darken around the edge of the growth. After three or four weeks the whole surface of the colony became black, shiny, wrinkled and more or less leathery. The pycnospores and conidia germinated well in water, germinating most commonly from the end cells but occasionally from either of the others.

Pathogenicity

Pycnospore isolations were made from diseased leaves. Inoculation experiments were conducted which resulted in the reproduction of the disease after about two weeks showing that the fungus was pathogenic on the leaves of barley. It did not attack the hulls of the kernels, however. Both leaf sheaths and leaf blades were very susceptible. The pycnidia were more prominent on the sheaths and they were always distinctly arranged in rows parallel to the vascular strands. At Madison, Wisconsin, the fungus lived over winter in a manner similar to *S. tritici* on wheat. More than 90 per cent of the pycnospores collected in the field in April, 1922, from barley plants which had been heavily infected in September, 1921, germinated.

A series of cross inoculations were made in order to determine whether or not this fungus was pathogenic on wheat and other cereals. The inoculations were made on a plot containing about forty species and varieties of cereals and grasses. The inoculum consisted of a water suspension of pycnospores from infected barley leaves. The plants were sprayed with the inoculum by an atomizer and immediately covered with paper bags for two or three days. The results of these experiments are given in table 6 and graphically shown in figure 2.

The inoculations gave negative results on all host plants tried except species and varieties of *Hordeum*. On the members of this genus infection was rather uniform. The disease was produced in 1365 of the 1792 leaves which were inoculated.

SUMMARY

1. The Septoria leaf-blotch of barley previously reported from Italy, and from North Dakota, South Dakota, and Minnesota in the United States has been found in Wisconsin.

2. The causal fungus has been found pathogenic only on species and varieties of *Hordeum*. It is of no economic importance at the present time.

3. The causal organism has been found to be *Septoria passerinii* Sacc.

4. Pycnospores measure 1.7–3 by 23–46μ.

5. The organism grows readily on potato-dextrose agar, forming flesh colored colonies of conidia, becoming black with age.

SEPTORIA LEAF BLOTCH OF QUACK GRASS (AGROPYRON REPENS)

In connection with the investigations of the Septoria diseases of cereals conducted by the writer, *Septoria agropyri* Ell. and Ev. on *Agropyron repens*, *S. bromi* on *Bromus inermis* and *Septoria sp.* on *Poa pratensis* were isolated and grown in pure culture. Their pathogenicity was tested on the various grains and grasses.

This disease on quack grass (*Agropyron repens*) was first noted by Dr. J. J. Davis near Racine, Wisconsin, in 1892 (1). From material collected by him, Ellis and Everhart (4) described the fungus in 1893 as *Septoria agropyri*. The writer has noted this disease (in virulent form on quack grass) in various places in the vicinity of Madison, Wisconsin, during 1920 and 1921. In one case near the experiment station plots the disease was found on every plant, and on the average 90 per cent of the leaves were attacked and most of them were completely involved. In this particular patch of quack grass the number of heads developed was reduced from 50 to 60 per cent.

The symptoms of the disease are characteristic of Septoria infections. The leaves are severely attacked and become yellowish and soon turn brown and die. The pycnidia are somewhat smaller than the pycnidia of some other Septorias but they are prominent and seriately arranged.

CAUSAL ORGANISM

As previously stated the causal fungus *S. agropyri* was described and named by Ellis and Everhart in 1893.

Mycelium.—Scant in culture, hyaline, septate, branched.

Pycnidia.—Subepidermal, black, subglobose, smooth, seriately arranged, averaging 100μ in diameter.

Ostiole.—Narrowly elliptical under stomata.

Pycnospores.—(Fig. 7, D) Straight or curved, rounded ends, smooth, 3-septate, hyaline, slightly guttulate, 1.5–2.5 by 24–45μ, most commonly 2 by 34μ.

The fungus was readily obtained in pure culture by the employment of methods already described. The pycnospores were germinated on potato-dextrose agar plates. Single germinating pycnospores were then transferred to culture tubes.

Upon germination the pycnospores enlarged somewhat and after from 6 to 8 hours, small buds were developed near the septa. These developed into conidia very similar to the pycnospores. These conidia in turn germinated after 36 hours and thus colonies were formed, which were circular, raised, smooth, and of a pinkish rose color. After several days the surface became wrinkled and after two weeks it became black and more or less tough. Plants of *Agropyron repens* both out-of-doors and in pots in the greenhouse were inoculated which showed characteristic symptoms of the disease after two weeks. A large number of cereals and grasses were inoculated to determine the host range of this fungus. The data obtained are summarized in table 1 and the results represented diagramatically in figure 3.

As shown in table 1 and figure 3, *S. agropyri* attacks *Agropyron repens* readily but none of the cereals or any of the other grasses tested. Other species of Agropyron were not available for testing at the time.

SUMMARY

1. The Septoria leaf-blotch of quack grass was found in Wisconsin by J. J. Davis in 1892. The causal fungus was first described in 1893 from Wisconsin material by Ellis and Everhart as *Septoria agropyri.*

2. As far as known the disease attacks only *Agropyron repens.* It is of no economic importance.

3. Mycelium, conidia, pycnidia, and pycnospores of the fungus have been developed on potato-dextrose agar cultures.

4. The pycnospores and conidia are hyaline, 3-septate, They most commonly measure 2 by 34μ.

SEPTORIA LEAF BLOTCH OF BROME GRASS

This disease of brome grass (*Bromus inermis*) caused by *Septoria bromi* Sacc. was found by the writer on the experiment station grounds at

Madison, Wisconsin, June, 1920. It was not very abundant but since it was found along the borders of grain fields infected with Septoria diseases the fungus was isolated and inoculation experiments conducted on the various grains and some of the grasses. *Septoria bromi* was first found at Parma, Italy, by Saccardo, and described and named by him in 1884 (10). The fungus was first found in Wisconsin on *B. secalinus* by E. T. Bartholomew in 1912 and in 1918 by J. J. Davis on *B. altissimus* (1, 2).

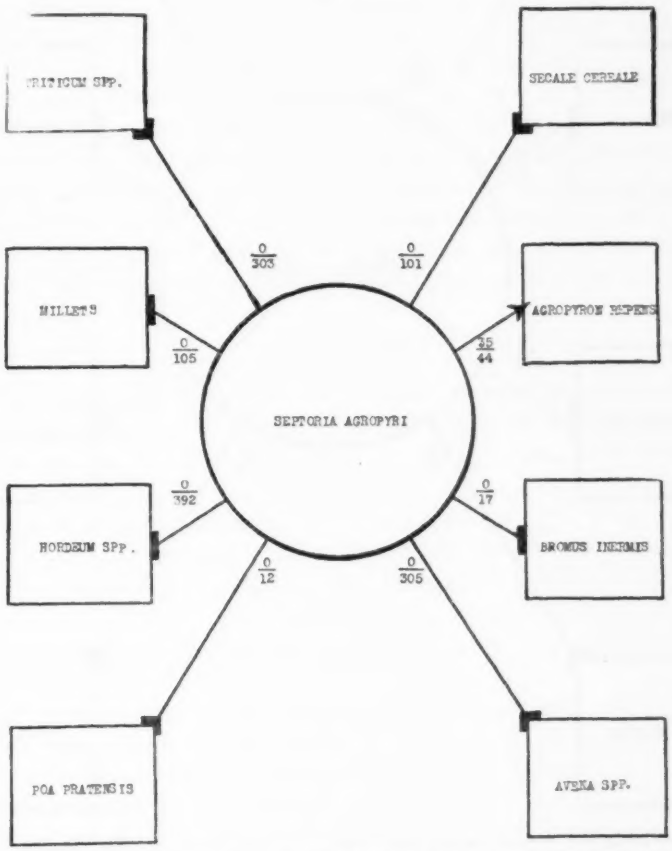

FIG. 3.—Diagram showing results of inoculation experiments with *Septoria agropyri*. Pycnospores were sprayed on the plants named in the rectangles. The denominator and numerator of the fraction show the number of leaves inoculated and the number of leaves infected respectively.

The symptoms of the disease on brome grass (*B. inermis*) are very similar to those caused by Septorias on other gramineous hosts. The

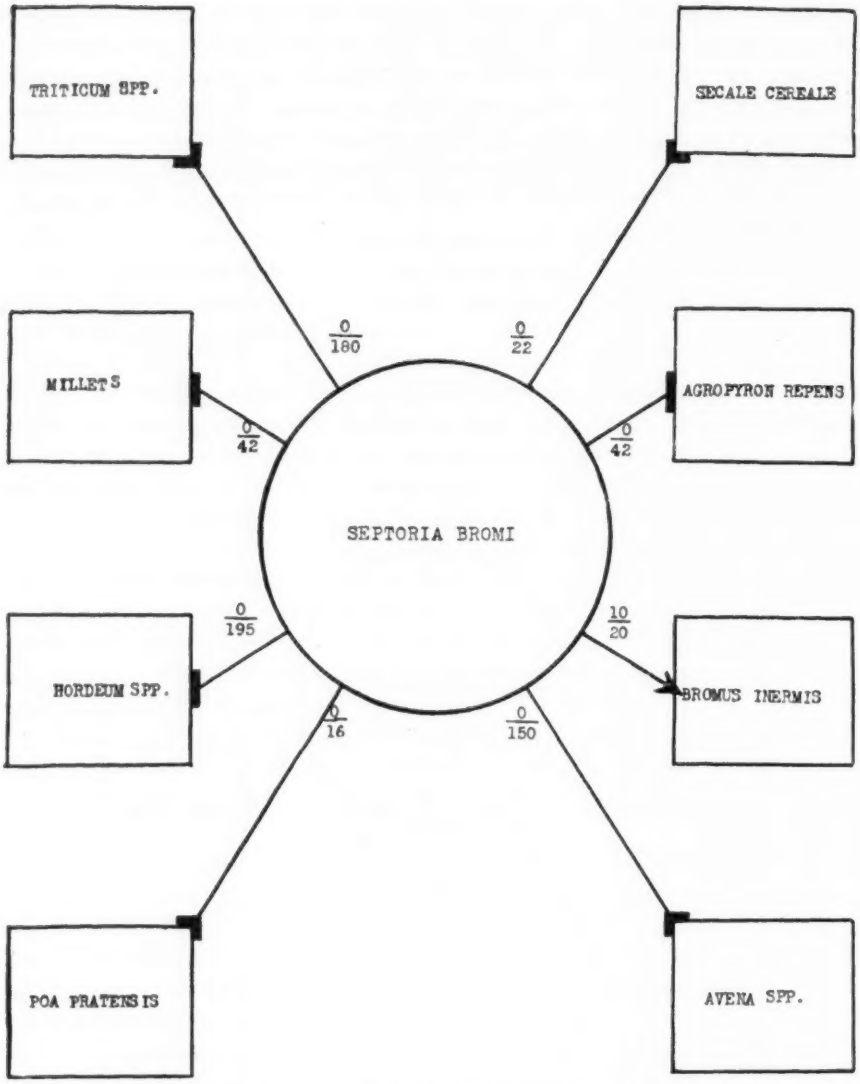

FIG. 4.—Diagram summarizing the results of inoculation experiments in which pycnospores of *Septoria bromi* Sacc. were used as inoculum. The plants named in the rectangles were inoculated. The denominator and numerator of the fraction show the number of leaves inoculated and the number of leaves infected respectively. The arrow indicates infection.

infected leaves usually turn yellowish, dry up and die prematurely. The pycnidia are fully developed shortly before the leaf begins to dry up. The leaf blades and leaf sheaths only have been found attacked. The disease very seldom involves the whole leaf and consequently it is not considered to be of much economic importance. The fungus is readily isolated in culture. The mycelium is white in colonies but single hyphae are hyaline. The hyphae are branched, septate, and often decidedly vacuolate. The pycnidia are subepidermal, seriate, black, smooth, subglobose, 80–110μ in diameter. The pycnospores are (Fig. 7, B) cylindrical, septate, hyaline, usually curved, with ends rounded, slightly guttulate, measuring 1.5 to 2.5 by 31 to 57μ usually 2 by 43μ (Fig. 8). The pycnospores obtained by soaking the leaf in water were sprayed with an atomizer on the leaves of a large number of species and varieties of cereals and grasses. The inoculated plants were covered for 48 hours immediately following inoculation. The results of these experiments are summarized in table 1 and are shown diagramatically in figure 4.

As shown in table 1 and figure 4, *S. bromi* will attack only *Bromus inermis*. The host range on the genus *Bromus* has not as yet been worked out.

SUMMARY

1. The disease of brome grass (*Bromus inermis*) caused by *S. bromi* has been previously reported only from Italy. It is reported here for the first time in the United States. Thus far, it has been found to be of negligible economic importance.
2. The fungus grows readily in artificial culture.
3. Pycnospores measure 1.5 to 2.5 by 31 to 50μ, mostly 2 by 43μ.
4. The fungus will not infect the common cereals.

LEAF BLOTCH OF KENTUCKY BLUE GRASS

This disease of Kentucky blue grass (*Poa pratensis*), caused by *Septoria sp.*, was found by the writer in September, 1920, on the campus of the University of Wisconsin at Madison. In certain areas every leaf was attacked by the fungus. It was found that this fungus compared favorably with the description of *Septoria graminum* given by Desmazieres (3). An examination of the type material showed that the lesions were long and narrow, decidedly delimited by the veins; also that the pycnidia which were almost invisible to the unaided eye were seriately arranged, smaller, and measured 45 to 75μ in diameter. The pynospores were found to measure 1 by 22 to 38μ. In contrast to this the lesions on blue grass were not delimited by the veins. They

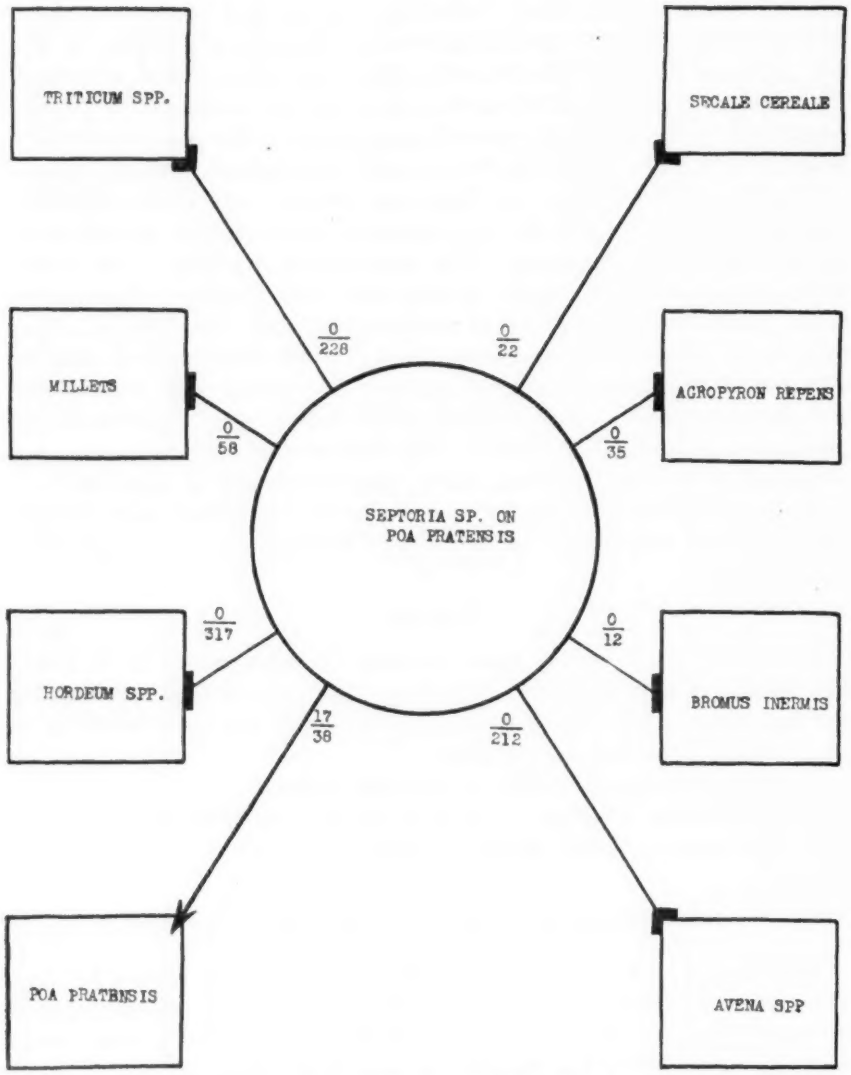

FIG. 5.—Diagram summarizing the results of inoculations with pycnospores of *Septoria sp.* from *Poa pratensis*. Cereals and grasses inoculated are named in rectangles. The denominators and numerators of the fractions give the number of leaves inoculated and the number of leaves infected respectively. Arrows indicate infection.

formed a circular or oval spot either at one edge or across the whole leaf. The pycnidia, measuring 50 to 120μ in diameter, were plainly visible to the unaided eye. They were much less closely seriately arranged. The pycnospores measure 1 to 1.5 by 29 to 57μ. From the comparion with the type material this disease on blue grass is distinct from *S. graminum* Desm. However, in a comparison of the description of *S. graminum* (which does not include measurements) the two organisms appear to be closely related. The organism on blue grass was cultured and the pycnospores were used as inoculum in cross inoculation experiments to be described later. The symptoms were somewhat different from Septoria infections on the cereals. The lesions are more sharply delimited, the band of yellow narrower, and the center of the spot is killed quicker and finally becomes chocolate brown. The spots are dark rather than light colored at the time the pycnidia are mature which is not characteristic of Septoria diseases in the cereals. The infection is also more localized on the leaves than in the cereals. Entire leaves are seldom involved. The fungus grows readily in culture. On potato-dextrose agar the mycelium is scant, branched, hyaline, septate. The pycnidia are subepidermal, loosely seriate, smooth, black, subglobose, about 120μ in diameter. The pycnospores are (Fig. 7, C) cylindrical, straight or slightly curved, hyaline, 3-septate, septa often indistinct, and rounded at the ends.

The pycnospores were obtained in pure culture and upon germination developed conidia and colonies. Growth in culture was found to be very similar to that of *S. tritici* and *S. agropyri*. Cross inoculations were conducted on different cereals and grasses, the results of which are given in table 1 and shown graphically in figure 5.

As shown in table 1 and figure 5, this *Septoria sp.* on *Poa pratensis* will not attack the cereals or certain grasses but attacks *Poa pratensis* fairly readily. The host range in the genus Poa has not been determined.

SUMMARY

1. The Septoria leaf blotch found on *Poa pratensis* at Madison, Wisconsin, is not *S. graminum* Desm.

2. The fungus grows well on potato-dextrose agar producing conidia abundantly.

3. Of the 40 different grains and grasses inoculated infections were obtained only on *Poa pratensis*.

4. The pycnospores of this fungus measure 1 to 1.7 by 30 to 50μ, mostly 1.5 by 30μ.

TABLE 1

Summary of results from inoculating various grains and grasses with seven species of Septoria and Leptospaeria avenaria.

Hosts	Sources of inoculum[1]	No. of leaves		Hosts	Sources of inoculum[1]	No. of leaves	
		Inoculated	Diseased			Inoculated	Diseased
Avena barbata	1	41	9	Avena brevis	1	44	4
	2	29	0		2	22	0
	3	19	0		3	22	0
	4	109	0		4	136	0
	5	131	0		5	127	0
	6	29	0		6	36	0
	7	181	0		7	168	0
	8	25	0		8	14	0
Avena fatua	1	43	7	Avena nuda chinensis	1	36	4
	2	31	0		2	52	0
	3	8	0		3	20	0
	4	171	0		4	108	0
	5	112	0		5	136	0
	6	28	0		6	23	0
	7	170	0		7	185	0
	8	12	0		8	26	0
Avena sativa (Culbertson)	1	96	18	Avena sativa nigra	1	40	11
	2	38	0		2	14	0
	3	18	0		3	19	0
	4	170	0		4	133	0
	5	149	0		5	126	0
	6	26	0		6	12	0
	7	176	0		7	184	0
	8	21	0		8	29	0
Avena sativa orientalis	1	31	5	Avena sterilis (b)	1	43	8
	2	23	0		2	52	0
	3	7	0		3	17	0
	4	119	0		4	137	0
	5	124	0		5	115	0
	6	9	0		6	20	0
	7	167	0		7	105	0
	8	22	0		8	21	0

[1] The inoculum used in these experiments consisted of spore suspensions of the following fungi:

1. *Leptosphaeria avenaria*
2. *Septoria agropyri*
3. *Septoria bromi*
4. *Septoria nodorum*
5. *Septoria passerinii*
6. *Septoria secalis*
7. *Septoria tritici*
8. *Septoria sp.* on *Poa pratensis*

Hosts	Sources of inoculum	No. of leaves		Hosts	Sources of inoculum	No. of leaves	
		Inoculated	Diseased			Inoculated	Diseased
Avena sterilis (a)	1	56	11	Avena strigosa	1	47	3
	2	12	0		2	38	0
	3	4	0		3	18	0
	4	130	0		4	136	0
	5	129	0		5	136	0
	6	7	0		6	26	0
	7	211	0		7	183	0
	8	17	0		8	25	0
Hordeum deficiens	1	31	0	Hordeum horsfordianum	1	77	0
	2	26	0		2	51	0
	3	27	0		3	20	0
	4	132	0		4	287	0
	5	129	91		5	287	224
	6	32	0		6	37	0
	7	188	0		7	406	0
	8	38	0		8	41	0
Hordeum distichon erectum	1	18	0	Hordeum distichon nudum	1	24	0
	2	32	0		2	27	0
	3	6	0		3	24	0
	4	140	0		4	130	0
	5	129	110		5	159	138
	6	29	0		6	26	0
	7	215	0		7	200	0
	8	28	0		8	26	0
Hordeum distichon nutans	1	19	0	Hordeum jubatum	1	18	0
	2	31	0		2	11	0
	3	17	0		3	12	0
	4	172	0		4	0	0
	5	165	130		5	0	0
	6	30	0		6	0	0
	7	193	0		7	91	0
	8	15	0		8	0	0
Hordeum vulgare coerulescens	1	22	0	Hordeum vulgare hexastrichum	1	20	0
	2	25	0		2	32	0
	3	10	0		3	17	0
	4	111	0		4	136	0
	5	149	124		5	128	98
	6	23	0		6	16	0
	7	204	0		7	186	0
	8	16	0		8	17	0

Hosts	Sources of inoculum	No. of leaves		Hosts	Sources of inoculum	No. of leaves	
		Inoculated	Diseased			Inoculated	Diseased
Hordeum vulgare himalaya	1	21	0	Hordeum vulgare nigrum	1	23	0
	2	30	0		2	31	0
	3	25	0		3	6	0
	4	192	0		4	135	0
	5	134	104		5	139	91
	6	35	0		6	22	0
	7	184	0		7	321	0
	8	31	0		8	37	0
Hordeum vulgare pallidum	1	20	0	Hordeum vulgare trifurcatum	1	25	0
	2	38	0		2	47	0
	3	23	0		3	8	0
	4	150	133		4	129	0
	5	150	0		5	149	110
	6	11	0		6	43	0
	7	239	0		7	210	0
	8	17	0		8	18	0
Barley, Mauriat X Lion	1	0	0	Secale cerale	1	29	0
	2	11	0		2	101	0
	3	0	0		3	22	0
	4	136	0		4	345	232
	5	274	214		5	182	0
	6	21	0		6	72	71
	7	123	0		7	256	138
	8	31	0		8	22	0
Triticum aestivum	1	118	0	Triticum compactum	1	32	0
	2	101	0		2	30	0
	3	74	0		3	11	0
	4	769	534		4	100	121
	5	590	0		5	148	0
	6	90	0		6	28	0
	7	753	550		7	191	104
	8	66	0		8	31	0
Triticum dicoccum	1	56	0	Triticum durum	1	35	0
	2	55	0		2	25	0
	3	24	0		3	21	0
	4	317	218		4	160	122
	5	319	0		5	148	0
	6	53	0		6	20	0
	7	411	0		7	181	124
	8	36	0		8	33	0

Hosts	Sources of inoculum	No. of leaves		Hosts	Sources of inoculum	No. of leaves	
		Inoculated	Diseased			Inoculated	Diseased
Triticum monococcum	1	32	0	Triticum polonicum	1	31	0
	2	18	0		2	30	0
	3	8	0		3	16	0
	4	160	109		4	172	120
	5	132	0		5	160	0
	6	18	0		6	24	0
	7	209	134		7	203	124
	8	9	0		8	22	0
Triticum spelta	1	26	0	Triticum turgidum	1	26	0
	2	30	0		2	14	0
	3	18	0		3	8	0
	4	216	166		4	159	115
	5	152	0		5	122	0
	6	39	0		6	30	0
	7	138	109		7	183	133
	8	19	0		8	12	0
Agropyron repens	1	35	0	Bromus inermis	1	24	0
	2	44	38		2	17	0
	3	14	0		3	20	10
	4	234	0		4	23	0
	5	145	0		5	11	0
	6	34	0		6	14	0
	7	216	0		7	110	0
	8	35	0		8	12	0
Chaetochloa italica	1	17	0	Chaetochloa viridis	1	19	0
	2	34	0		2	16	0
	3	6	0		3	17	0
	4	61	0		4	109	0
	5	80	0		5	102	0
	6	15	0		6	20	0
	7	148	0		7	19	0
	8	16	0		8	11	0
Echinochloa crus-galli	1	17	0	Panicum clandestinum	1	25	0
	2	21	0		2	9	0
	3	10	0		3	0	0
	4	109	0		4	96	0
	5	78	0		5	71	0
	6	29	0		6	24	0
	7	178	0		7	127	0
	8	0	0		8	13	0

Hosts	Sources of inoculum	No. of leaves		Hosts	Sources of inoculum	No. of leaves	
		Inoculated	Diseased			Inoculated	Diseased
Pannisetus glaucum	1	15	0	Poa pratensis	1	54	0
	2	25	0		2	12	0
	3	9	0		3	16	0
	4	76	0		4	237	96
	5	82	0		5	206	0
	6	22	0		6	25	0
	7	151	0		7	183	80
	8	10	0		8	38	17

Table 1 has been discussed more or less in the several parts of this paper under the different diseases. This table contains data from all of the inoculation experiments conducted. Eight distinct species of Septoria have been used separately as inocula in inoculating each of the plants given in this table. The data show that *Leptosphaeria avenaria* from oats, *Septoria passerinii* from barley, *S. secalis* from rye, *S. agropyri* from quack grass, *S. bromus* from brome grass, and *Septoria sp.* from *Poa pratensis* are sharply specialized to the hosts on which each was found. While *S. tritici and S. nodorum* are less specialized in that, in both cases, they attack rye and *Poa pratensis* in addition to the different species and varieties of wheat.

SUMMARY

1. On oats, wheat, barley, rye, and certain grasses (Fig. 6) there is a group of similar diseases caused by a number of closely related species of Septoria. These species have been found to be morphologically and physiologically distinct. The ascigerous stage of one of these species has been found.

2. Certain of these diseases occur widely distributed throughout the world and may become of considerable economic importance, while others are known to occur only locally and, as far as known, are of no economic importance.

3. Most of these diseases occur only on the leaves. One of them, however, is found on the glumes of wheat. In this case the lesions are localized, usually brown in color with pycnidia present in the later stages of development. On the leaves the lesions are, in general, similar on the various hosts. In each case, the lesions are localized, of various

sizes and forms, variously bleached or discolored, and in the later stages they show the presence of dark colored pycnidia.

4. On oats there occurs only one disease of this group. It is caused by the fungus previously known as *Septoria avenae* Frank. However, the ascigerous stage of this fungus has been found which proves to be

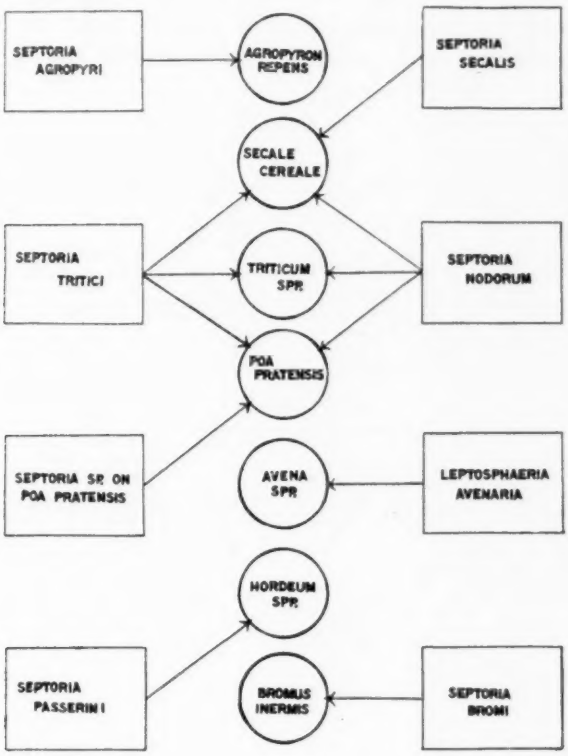

FIG. 6.—Summary of the positive results obtained as shown in table 6. The circles represent the plants inoculated; the rectangles, the organisms with which the inoculations were made. Arrows indicate infection.

a species of Leptosphaeria. The specific name *avenae* having been previously used in the genus Leptosphaeria for another fungus, a new species name *L. avenaria* is given. This fungus attacks only oats. On wheat there are two diseases caused by *Septoria nodorum* Berk. and *S. tritici* Desm., respectively. Both of these fungi have the same host range. They both attack rye and Kentucky blue grass in addition to wheat.

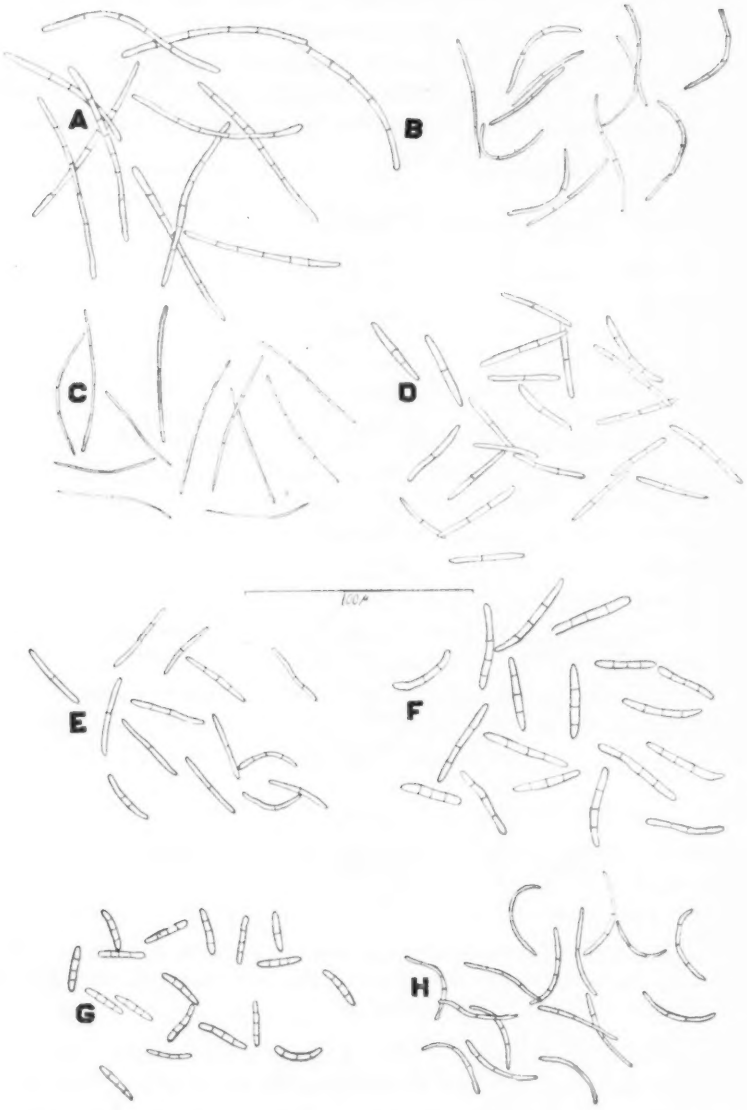

FIG. 7.—Camera lucida drawings of pycnospores collected in the field. Magnification the same throughout. A. *Septoria tritici* on wheat. B. *Septoria bromi* on brome grass (*Bromus inermis*). C. *Septoria sp.* on Kentucky blue grass (*Poa pratensis*). D. *Septoria agropyri* on quack grass (*Agropyron repens*). E. *Septoria secalis* on rye. F. *Leptosphaeria avenaria* on oats. G. *Septoria nodorum* on wheat. H. *Septoria passerinii* on barley.

There is also a disease of rye caused by *S. secalis* Prill. and Del., which is parasitic on rye only.

On barley there is only one disease of this group which is caused by *S. passerinii* Sacc. A disease of quack grass, brome grass, and Kentucky blue grass, caused by *S. agropyri* Ell. and Ev., *S. bromi* Sacc., and *Septoria sp.*, respectively.

5. While the eight species of fungi concerned are in general very similar, they are also distinctly different both morphologically and

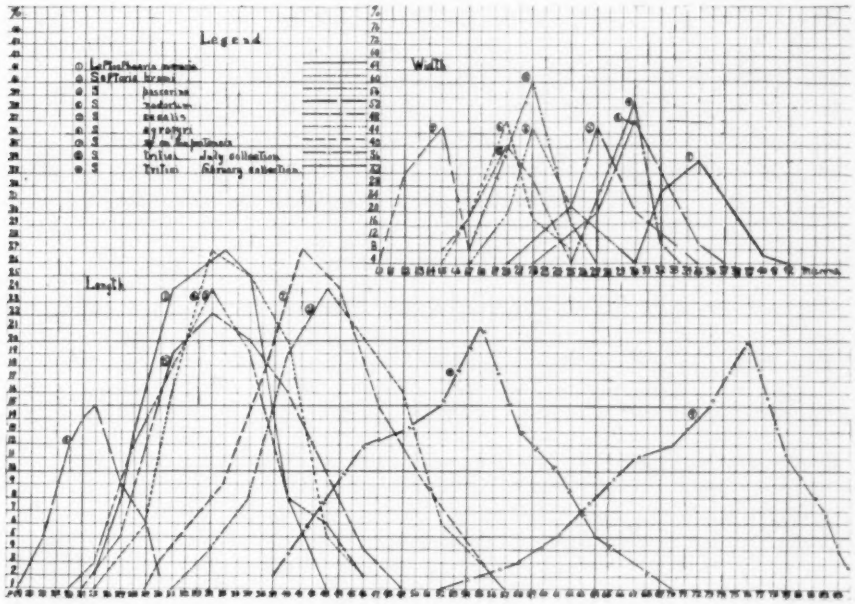

FIG. 8.—Graph showing widths and lengths of pycnospores of different fungi as indicated. Each graph represents 100 spores measured. In each case the ordinates indicates the percentages of spores of different length (in microns) and width in tenths of microns, as indicated by the abscissae.

physiologically. The ascigerous stage has been definitely found for only one of these fungi, namely *Leptosphaeria avenaria*. The pycnidia of each, however, are fairly characteristic both as to form and size, as shown in figures 7 and 8. *Septoria tritici* has the largest pycnospores and *S. nodorum* the smallest. The pycnospores of *Septoria sp.* from *Poa pratensis* are the most slender. Those of *S. bromi* and *S. passerinii* are the most alike, those of the latter, however, being somewhat shorter. The pycnospores of *Leptosphaeria avenaria and S. agropri* are similar in

general shape, those of the former being distinctly wider. All eight species grow readily and produce pycnidia on artificial media. *Septoria tritici*, *S. passerinii*, *S. agropyri*, and *Septoria sp.* from *Poa pratensis*

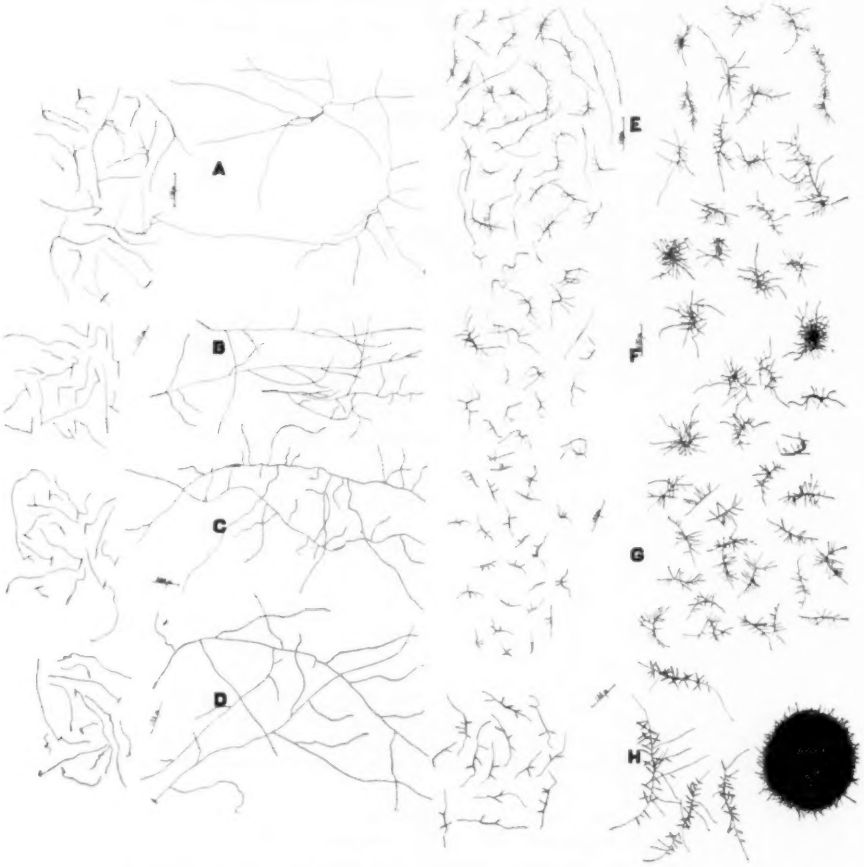

FIG. 9.—Camera lucida drawings of pycnospores germinating on potato-dextrose agar plates. A. *Leptosphaeria avenaria*. B. *Septoria bromi*. C. *S. secalis*. D. *S. nodorum*. E. *S. sp.* on *Poa pratensis*. F. *S. passerinii*. G. *S. agropyri*. H. *S. tritici* also 5 day old colony.

With the exception of *S. tritici* (H) growth at left and right is 24 and 48 hours old respectively. Growth of *S. tritici* (H) at left is 24 and at center 48 hours old. At right is a 5 days old colony.

produce conidia from scant hyaline mycelium. As cultures get older olivaceous hyphae are produced. In contrast to these, *Leptosphaeria avenaria*, *Septoria nodorum*, *S. secalis*, and *S. bromi* produce abundant mycelium, which is cottony at first, later becoming more or less olivace-

ous. In the latter group conidia have been noted only in cultures of *S. nodorum*, and there only rarely. In the latter group the pycnospores germinate by the production of an abundant mycelium, while in the former only scant mycelium and abundant conidia are formed (Fig. 9).

6. The pathological changes in the host tissue caused by these eight fungi are similar. The mycelium grows between the cells of the parenchyma. The pycnidia are subepidermal in substomatal chambers. In the cases of *Leptosphaeria avenaria* on oats, *S. tritici* and *S. nodorum* on wheat, and *S. passerinii* on barley it was found that the germ tubes penetrate the cuticle. They then grow in between the epidermal and parenchyma cells.

7. As a result of inoculation experiments the incubation period has been found to be from 11 to 15 days. The incubation period is here considered to be the time elapsed between the sowing of the spores on the host tissue and the maturing of the pycnidia. The first symptoms become noticeable about 8 days after inoculation.

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THE TRANSMISSION OF SUGAR-CANE MOSAIC BY APHIS MAIDIS UNDER FIELD CONDITIONS IN PORTO RICO.

C. E. Chardon and R. A. Vevè.

With One Figure in the Text.

During the course of an investigation on the ecological factors bearing on the spread in the field of the mosaic disease of sugar-cane, the senior author has repeatedly realized the importance of insects as the probable agents for the transmission of the disease. The relation of rainfall, humidity, temperature and age of the cane plants to the spread of the disease is considered as important, especially since very little is known about them; but the question of the transmission of the disease by insects has come forth as vital, since it is only after a thorough comprehension of it, that we can understand how the spread of the disease takes place. How is the disease transmitted in the field? What insects are responsible for its transmission in the field? These questions have, to the present time, defied all the attempts made by entomologists to solve them.

The work of Brandes (1), in this respect, has proven to be very guiding and suggestive. He succeeded in transmitting the disease from diseased to healthy plants by means of the corn aphid, *Aphis maidis*, in the greenhouses at Washington, D. C. His results have been accepted as conclusive. Brandes, however, did not actually solve the problem of insect transmission in the field. In the discussion of his results he says (p. 137): "Just what insects are responsible for dissemination in the cane regions remains to be proved." The fact that *Aphis maidis* does not ordinarily occur on cane has led entomologists to pay little or no attention to it, and has induced them to try extensive cage experiments using other insects which are known to occur on sugar-cane. All these attempts have met with failure.

Smyth (5), in 187 trials with different insects, had only 4 successful takes, and each one of them with a different species of insect. He says (p. 111): "In view of the small number of successful inoculations secured, as compared with the rather large number of tests made, under conditions which were considered favorable, the question of insect transmission of cane mottling disease can not be looked upon as settled." In another publication (6), he states that out of 310 additional experiments, only 9 gave positive results. The work of Smyth has been con-

tinued by Wolcott, who has published a comprehensive study (7) of all the minor sugar-cane insects of Porto Rico. The importance of these minor insects, he says (p. 5): "lies not in the injuries which they cause directly, but in the possible connection that may exist between one, or some of them, and the rapid spread of a disease, new to Porto Rico, the mottling or mosaic disease of sugar-cane." He paid special attention to the study of the leafhoppers, whose abundance in sugar-cane fields has attracted the attention of all workers on the disease. Wolcott accepts Brandes' work, but in regard to the occurrence of *Aphis maidis*, he says (p. 34): "The corn aphis has not been found on cane in Porto Rico. It can not in any way be considered responsible for the transmission of mosaic disease of sugar-cane under field conditions in Porto Rico." Further transmission experiments carried on by Wolcott, at the Insular Experiment Station, and using the common leafhopper *Kolla similis*, have met with failure. The results of the insect transmission experiments at the Federal Experiment Station at Mayaguez, P. R., have not been published yet, but 86 trials have been made by the entomologist, especially with the yellow aphis, *Sipha flava*, and all of them have given negative results. Ledeboer (4), in a short report from Java, reports a successful inoculation with *Aphis sacchari*, but he does not mention the number of failures, and consequently, his work seems questionable. Thus the situation as regards the transmission of the disease by insects, and specially, the spread of the disease in the field remains, as Prof. F. S. Earle (3, p. 18) says: "dependent on some factor or factors as yet absolutely indiscovered."

In a very recent publication, Bruner (2) has succeeded in duplicating Brandes' results with *Aphis maidis*, at the Experiment Station at Santiago de las Vegas, Cuba. In two series of experiments, he succeeded in getting 14.2 and 11.1 per cent positive inoculations with the use of the corn aphid. In his opinion, however, the question of the insect transmission in the field is still unsolved. He says (p 21): "Even if the evidence shows that the green corn aphid can transmit the mosaic disease of sugar-cane, it does not solve the problem of dissemination, because this insect does not attack cane under ordinary field conditions" (in translation).

In view of the diversity of opinion of different authorities on this question, we have conducted field experiments, which in our opinion, have given us a clue towards its solution. We are attempting, for the first time, to give an explanation of how the spread of the disease in the field actually takes place. The sequence of events leading us to these experiments are as follows:

In one of the fields under observation by the senior author, located at Santa Rita, P. R., Mr. Wolcott found an abundance of *Aphis maidis* in the central whorl of leaves of the young cane plants. He could not say where the aphids came from, there being no corn nor sorghum in the immediate vicinity, but it was observed that this unexpected invasion by the aphids was followed by a sudden spread of the disease. The exact percentage of mosaic infection in this field follows:

Field No. 17:	Oct. 14	1.1 per cent	
Santa Rita.	Nov. 12	14.3 " "	(aphids collected Oct. 26)
	Dec. 9	35.8 " "	
	Jan. 7	43.2 " "	
	Feb. 20	51.4 " "	

A due importance was attached to this phenomenon, and in subsequent trips around the island, the senior author made special search for the aphid. It was found to occur in practically every sugar-cane field in Porto Rico. It was not living on cane but occurred on various common grasses. Curiously, however, after the weeding of a field, the aphids passed to the cane plants and lived in the central whorl of leaves. This obligate change of hosts, that is, from the grasses to the cane, was invariably followed by a sudden spread of the disease, irrespective of the presence or absence of leafhoppers or other minor insects.

With these facts on hand, highly suggestive of success, the need of experimentation on the subject became urgent. The Fajardo Sugar Co. very kindly volunteered its services to construct the cages needed for the experiment. We are specially indebted to the manager, Mr. Jorge Bird, for the interest he has shown in our work. The experiment was started under the direction of the junior author, in charge of the Fajardo Sugar Co. Experiments Station, and his immediate assistant Mr. Luis de Celis, who has taken special pains in the details of the experiment and which have decidedly contributed towards its final success.

Two insect-proof cages, 24 by 14 by 5 feet were constructed, using a fine mesh cheese-cloth. They were erected in the middle of a cane field, so as to be under perfect field conditions (Fig. 1), 48 seeds of the susceptible variety DIIII were planted in each cage at the ordinary field distances. In one case half of the seed used was diseased and the other half healthy. Field observations in the adjoining fields had shown *Aphis maidis* to occur on the common weed "malojillo" (*Eriochloa subglabra*). An abundance of this weed was planted in cage A, and a number of corn aphids introduced in it. Cage B was kept free from weeds and insects, so as to serve as a check on cage A.

A perfect germination of the cane seeds was secured, and the "malo-

jillo" together with other weeds grew luxuriantly in cage A. All weeds were systematically kept down in cage B. One month after planting the seed, when the cane plants were 6–8 inches high, a thorough weeding of cage A was done by a laborer. Among the weeds killed were: *Eriochloa subglabra, Cyperus rotundus, Echinochloa colona, Eleusine indica, Syntherisma sanguinalis, Portulacca oleracea, Chamaesyce hypericifolia, Commelina sp., Amarantus spinosus* and *Ipomoea tiliacea.* Among them, the "malojillo" (*Eriochloa subglabra*) was decidedly the preferred host

FIG. 1. A view of the cages used in the field transmission experiment at Fajardo, P. R.

for the aphid, although a few were seen on Echinochloa, Eleusine and Syntherisma.

The weeding was done at 5 P. M. Early in the next morning the aphids were seen apparently feeding in the central whorl of leaves of the young cane plants. They stayed on the cane for some time but as soon as weeds started to come up, they were seen on their favorite hosts.

The results followed in quick succession. Two weeks later, an evident case of secondary infection appeared in cage A; 17 days later 4 more cases appeared, and at the end of two months 15 out of the 24 plants had contracted the disease. This represents an infection of 62.5 per cent.

In cage B, used as a check, no cases of transmission have occurred and all the healthy plants have remained healthy for a period of over three months.

Three of the grasses present in cage A, *Syntherisma sanguinalis*, *Eleusine indica* and *Echinochloa colona*, very unexpectedly came out showing true symptoms of mosaic. It will be recalled that all three of them acted as hosts for the aphids. *Eriochloa subglabra*, the favorite host for the insect, did not show symptoms of mosaic, being apparently immune to it. This is not the first record of grasses becoming affected with sugar-cane mosaic. As a result of experiments Brandes reports three species which became affected with the disease. One of them, *Syntherisma sanguinalis*, is the same one that we report here.

It must be stated here to the credit of the experiment, that the region of Fajardo is far remote from all possible source of infection. There were no cases of the disease in all the fields adjoining our experiment. Consequently, the cases of secondary infections in cage A, must have come from the disease plants present within the cage itself. The disease must have also been transmitted by *Aphis maidis*, the only insect present. The proof for this last statement is that in cage B, where the aphid was absent, no transmission of the disease took place.

No further discussion nor comment about the experiment needs to be made, but its importance, in the opinion of the authors can not be overestimated. It opens a field of investigation partially neglected before, and suggests many experiments of an entomologic and agronomic nature bearing on the practical control of the disease. We consider it as a positive duplication of Brandes work, under ordinary field conditions at Fajardo, P. R., and with the use of insects common to that region. Since the rainfall, humidity and temperature records at Fajardo, during the time the experiment was running do not differ substantially from those of the rest of the island, we are led to believe that they represent the field conditions of most of the sugar-cane growing regions of Porto Rico.

We do not feel justified yet, to draw definite conclusions with regard to the insect transmission of the mosaic disease of sugar-cane and our experiments are given here merely as an introduction to the problem of insect transmission in the field. Much remains to be done yet. We feel safe, however, in saying that we have field observations and experimental evidence pointing out to the facts that:

1. *Aphis maidis* is found, with more or less abundance, in various grasses occurring in the sugar-cane fields of Porto Rico.

2. After the weeding of the fields, *Aphis maidis* passes to the sugar-cane plants living in the central whorl of leaves for a period of time.

3. During the short time that it stays on cane, *Aphis maidis* transmits the infective substance of the sugar-cane mosaic and carries the disease from diseased to healthy plants.

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A METHOD OF PHOTOGRAPHING SPORE DISCHARGE FROM APOTHECIA

F. Dickson and W. R. Fisher

With Two Figures in the Text

During some studies on the factors governing apothecial formation in *Sclerotinia libertiana* Fckl., an exceptionally large number of apothecia were obtained, in several instances more than one hundred of them arising from individual sclerotia. It was suggested by Professor H. H. Whetzel that an attempt be made to procure a photograph of the spore-cloud emanating from these fruit bodies, and, after some experimenting, the endeavour met with unusual success. This being the case, it is thought worth while to outline the method employed in making the photograph, in order that others may profit by our experiences. Without doubt, such illustrations may be effectively employed to give a vivid idea of the aerial dissemination of fungous spores.

So far as can be ascertained by the writer, no such attempt at photographing spore discharge has ever been reported before, although Pethybridge,[1] depicts what he calls "cloud-like puffs of spores" from apothecia of *Sclerotinia sclerotiorum* from potato. In this case, however, it is surmised that the apothecia were allowed to discharge their spores upon a flat surface and were then photographed, the spores not being actually in motion at the time.

The photographs accompanying this note were made by the junior author, photographer for the Department of Plant Pathology, using a camera equipped with a Voightlaender "dynar lens." An Eastman "portrait super-speed film," which is probably the fastest on the market at the present time, was used. The aperture was set at f. 6. 3 and the exposure given was 1/100th of a second.

The essentials upon which success depends may be summarized as follows:—

1. The apothecia, apart from being sufficiently abundant, must be in good condition, in order to produce a cloud of maximum density.
2. The background must be black or as nearly black as possible.

The matter of the actual growing of the apothecia will not be dealt with here but will be reserved for a future paper. In order to ensure that they would be in good condition for discharging spores a layer of absorbent cotton, saturated with water, was first placed on the inside of

[1] Pethybridge, George H. Potato diseases in Ireland. Jour. Dept. Agric. and Tech. Instruct. Ireland **10**: 241–256. *8 fig.* 1910.

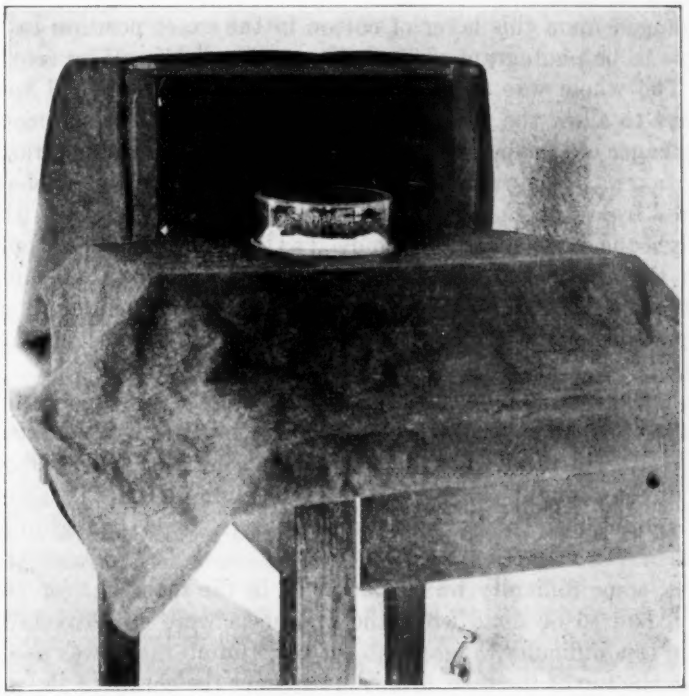

Fig. 1. Photograph showing the position of the dish containing apothecia, and the background when ready for photographing.

Fig. 2. Photogrph showing spore-cloud emanating from apothecia of *Sclerotinia libertiana* Fckl.

the lid of a six inch "stender dish." The sclerotia with apothecia were then arranged upon this layer of cotton in the exact position in which they were to be photographed, and the stender dish itself inverted over them. The whole was then placed out-of doors in a shaded spot for three days to allow the ascospores to mature. With this arrangement, no disturbance of the apothecia was necessary before the photograph was actually taken. This was important, for, as is well known, discharge of ascospores from the apothecia takes place on the least disturbance, especially if the cover should be removed so as to allow slight air currents to reach the apothecia. About two hours before the photograph was taken, the dish containing the apothecia was taken inside and placed in the position shown in figure 1, which illustrates the general plan adopted.

For a background, an empty box was first lined on the inside with black paper to render it light proof, and this, in turn, was covered with black velvet. The table was then arranged in a corridor, near a doorway, so that direct sunlight came from one side, illuminating the apothecia without shining into the box. In this way, a jet-black background was obtained.

At first, some difficulty was experienced in the focusing, for this, of necessity, had to be done while the apothecia were still covered. To overcome this difficulty, a small object (a "thumb-tack" was used) was placed on the top of the dish, immediately over the centre of the mass of apothecia and a sharp focus on this obtained. The final results showed that this gave a perfect focus on the apothecia when the cover was removed. Screens were so arranged as to prevent the wind from dispersing the spore-cloud.

When everything was prepared, the photographer stood ready at the bulb of the camera and, at a given word, the stender dish was quickly removed from the apothecia. Nothing happened for about one second, and then a sudden cloud of spores was discharged into the air, the exposure being made at the proper instant with the result shown in figure 2.

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ABSTRACTS OF PAPERS PRESENTED AT THE FOURTEENTH ANNUAL MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY, BOSTON, MASSACHUSETTS, DECEMBER 27 TO 30, 1922.

Recent studies on control methods of Texas root rot. J. J. TAUBENHAUS AND D. T. KILLOUGH.

Statements abound to the fact that the Texas root rot disease may be controlled by deep plowing or crop rotation in which non-susceptible hosts are grown during the rotation period. In our studies, we have found that these recommendations were not always successful because they were not made on a knowledge of the life history of the causal organism. The causal organism winters over on living roots of susceptible hosts.

Deep fall plowing does not control root rot because such a practice does not necessarily kill the cotton roots; neither does it always destroy the susceptible weeds, especially the Small Flowered Pink Morning Glory, *Ipomoea trichocarpa*, which is so common in the black lands of Texas.

Likewise, crop rotation does not control root rot even though a three- or four-year system is adopted in which non-susceptible crops are grown. In this case, the failure at control is due to the fact that the causal organism is permitted to live over during the fall and winter months on roots of perennial weeds which are commonly found on the stubble land of the grain or cereal crops which are used in the system of rotation.

It is possible to control root rot by fall plowing or crop rotation provided clean culture is practiced not only during the growing season, but also during the fall and winter months.

Cartoons in Agricultural Teaching. R. R. REPPERT.

The paper deals with the use of cartoons in teaching agricultural truths. During the past few months, cartoons, depicting the life history of the boll weevil, especially those phases having close relationship to fall and winter control measures, have been put out by the Division of Extension Entomology and Plant Pathology of the A. and M. College of Texas. The high interest they have aroused among the farmers over the state indicates they are a valuable means of extending knowledge on entomological subjects. It is believed that added interest may in the same way be given to subjects of plant diseases, among practical farmers with insufficient technical training to fully appreciate the more scientific phases of the subject.

The growth reactions of certain fungi to their staling products. C. BOYLE.

Fungi which develop for some time on solid or liquid media sooner or later show a marked diminution in rate of growth, varying with the organism and the medium used. Such "staling" effect is characteristic of a species of Fusarium originally isolated from

decaying apples when grown on Richard's solution, apple or potato extracts. The progress of staling was measured by the effect of the staled liquid on germination and growth of spores of *Botrytis cinerea*.

Growth of *Fusarium sp.* in the three media mentioned caused a change in pH towards the alkaline side. Correction of the pH had some effect in restoring capacity for germination and growth in the early stages, but the effect disappeared as the medium became more stale. Within wide limits, the pH value of a staled solution is not the limiting factor in growth.

The pH limits and optima for germination and growth of *Fusarium sp.* and *Botrytis cinerea* depend on the medium. Inhibition of germination is not caused by lack of nutrient material. The toxic effect is partly due to the presence of thermolabile substances. Precipitation by alcohol deactivates some of the inhibiting factors. Filtration through collodion membrane is partly effective in restoring its germinative capacity to staled Richard's solution indicating that some of the toxic substances present are colloidal in nature.

A survey of the evidence indicating that Phytophthora should be merged with Pythium. H. H. FITZPATRICK.

Attention is called to the fact that there is at present no known basis for the satisfactory separation of Pythium and Phytophthora. The researches of recent years show that these genera do not differ essentially in method of swarmspore discharge, the character mentioned by Butler as providing "the only absolute mark of distinction" between them. As no other tangible taxonomic character which might serve for their separation has been brought to light the attempt to maintain the two generic concepts results only in confusion. The writer, therefore, proposes the merging of the genera under the name Pythium which is the older. It is also recommended that the Pythiaceae consisting of the resultant genus and its nearest relatives be regarded as a distinct family of the Peronosporales. The Peronosporaceae differ in their simultaneous development of sporangia, in the production of more definite sporangiophores, in the absence of saprophytic tendencies, in their more typically deciduous sporangia, etc.

The production of conidia at night in species of Sclerospora. WM. H. WESTON, JR.

In two conidial Sclerosporas (*S. philippinensis* and *S. spontanea*), destructive to maize in the Philippines, the writer, in investigations conducted by the Office of Cereal Investigations, B. P. I., U. S. Dept. of Agriculture, found that conidia were produced only at night when the host surface was covered with dew or other moisture. In the case of a third species (*S. sacchari* T.Miy.), recently introduced into the Philippines where it is destructive to sugar-cane, material furnished through the cooperation of Mr. H. A. Lee of the Philippine Bureau of Science, exhibits the same peculiarity. The accounts by Butler and Palm suggest strongly that this condition obtains also in *S. maydis* (Rac.) But. of India, and *S. javanica* Palm of Java. From these five oriental species the cosmopolitan *S. graminicola* (Sacc.) Schroet., on which the genus Sclerospora was founded, differs sufficiently to raise the question whether it, as well, produces its conidia only at night in dew. The writer finds that it does, and he assumes this fundamental peculiarity will be found to hold in other conidial representatives of the genus. Realization that the Sclerosporas produce conidia only during favorable nights opens the way to the more complete knowledge of methods of dissemination and infection on which control of these destructive and hitherto baffling downy mildews must be based.

Heterothallism in Ophiobolus cariceti. R. S. KIRBY.

Monosporous cultures of *O. cariceti* (B. & Br.) Sacc. are of two distinct sexual types which when mixed in culture result in the formation of typical perithecia. These perithecia develop in four months either in petri dishes containing two per cent crushed wheat in agar or in test tubes on stems of wheat or *Melilotus alba*. On certain media such as potato agar, wheat agar, cornmeal and oatmeal agars a definite dark zone is produced along the line of union between colonies of different sexual types. No such lines are produced where colonies of the same sexual type meet. Monosporous cultures have retained their sexual types during hundreds of tests throughout a period of 20 months. Polysporous cultures during the same period have been segregated into sexual types which react sexually with each other or with monosporous cultures of the opposite sex type. Each of the 175 isolations of monosporous or polysporous origin have exhibited a definite sex type.

Biologic specialization of Puccinia graminis avenae. E. C. STAKMAN, M. N. LEVINE, AND D. L. BAILEY.

Puccinia graminis avenae Erikss. and Henn. consists of several biologic forms differing in infection capability on certain varieties of *Avena spp.* Four and probably five biologic forms of *P. graminis avenae* can be identified by their action on Victory (C. I. No. 1145), White Russian (C. I. No. 1614), and Monarch Selection. Victory is completely susceptible, White Russian very resistant, and Monarch Selection practically immune from one of the forms. A second form infects Victory and White Russian in much the same manner as Form 1, but produces heavy infection on Monarch Selection. A third form attacks Victory and Monarch Selection very heavily and White Russian moderately. All the three varieties are extremely susceptible to a fourth form. In some cases the heterogeneous (X) type infection described for wheat rust developed on Monarch Selection, thus indicating the probable existence of a fifth form. The behavior of these forms has been consistent. Forms I, II, and V, so far, have been found quite widely distributed in North America. Form IV was collected in Seden, while Form III came from South Africa.

(Cooperative experiments between the Office of Cereal Investigations, B. P. I., United States Department of Agriculture, and the Minnesota Agricultural Experiment Station.)

Biologic specialization of Puccinia graminis secalis. M. N. LEVINE AND E. C. STAKMAN.

As a result of inoculation experiments made by the Office of Cereal Investigations, United States Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station, it has been found that *Puccinia graminis secalis* Erikss. and Henn. consists of several biologic forms, as is the case with *P. graminis tritici* Erikss. and Henn., *P. graminis avenae* Erikss. and Henn., *P. coronata* Cda., and *P. triticina* Erikss. As rye is cross pollinated, the study of the biologic specialization of *P. graminis secalis* is more difficult than is that with the other rusts for which pure lines of differential hosts may be obtained with comparative ease. However, even commercial varieties of rye, such as Rosen, Swedish, and Prolific, react sufficiently clearly to indicate that there are at least two and probably three distinct biologic forms of *P. graminis secalis*. One form is quite virulent, possessing the capability of attacking heavily all the three varieties; another form attacks Rosen very heavily. Prolific only moderately and Swedish very weakly; while still another form produces normal infection on Swedish and Prolific, but only weak infection on Rosen.

Strains of the leaf-rust of wheat, Puccinia triticina, in the United States. E. B. MAINS AND H. S. JACKSON.

Cultures of leaf-rust of wheat from various parts of the United States, sown on 200 varieties of wheat, have shown that this rust is not uniform but consists of at least 12 strains differentiated by their action on 7 varieties, Malakof (C. I. No. 4898), Mediterranean (C. I. No. 5776), Democrat (C. I. No. 3384), and 4 unnamed spring wheats, C. I. Nos. 3756, 3778, 3779, and 3780. As a number of the cultures showed themselves to be mixtures, it was found advisable to make the final study from cultures started from a single spore, and 18 of these have been studied. As a result, 24 wheat varieties in addition to the 7 listed above have been found to be differential hosts, in the seedling stage under greenhouse conditions, to one or more strains of the leaf-rust. These are divided as follows: *Triticum aestivum*, winter 7, spring 5; *Triticum durum* 5; *Triticum dicoccum* 3; *Triticum spelta* 2; *Triticum monococcum* 1; *Triticum polonicum* 1. No variety was found absolutely immune from all strains and none of the cultures so far tested has been found to produce a high degree of infection on all these varieties. There seems to be more or less mixture of rust strains in the field but oftentimes different ones predominate in different sections. Some wheats, especially of the Turkey type, have shown high resistance in the field while showing considerable susceptibility in the greenhouse. (Cooperative investigation between Purdue Agriculture Experiment Station and Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Wheat smut investigations in Kansas: Report of progress 1920–21. C. O. JOHNSTON.

Kanred, one of the principal varieties of hard winter wheat grown in Kansas, has been shown to be resistant to *Tilletia tritici* (Bjerk.) Wint. One year's results indicate that it shows resistance to this species of smut under Kansas conditions. In contrast to this, however, two years' results show that Kanred exhibits no more resistance to *T. levis* Kuehn, the species commonly found in Kansas, than Turkey, Kharkof, and other hard winter wheats. Soft red winter wheats, as a group, seem to be somewhat more susceptible to *T. levis* than do the hard red winter varieties.

Later dates of planting show consistently higher percentages of bunt than the earlier plantings, the amount of smut gradually increasing in consecutive plantings from September 15 to November 1, after which the percentage of infection rapidly declines.

Experimental data show that under conditions in eastern Kansas, spores of *Tilletia levis*, falling on the soil during August, do not seem to be a factor in producing bunt infection. This is perhaps not true for western Kansas where summer fallowing is practiced and summer rainfall is less. Further investigations are being conducted to prove this point.

Cytological studies on the infection of wheat seedlings by Tilletia tritici (Bjerk.) Wint. H. M. WOOLMAN.

Cytological studies conducted by the Office of Cereal Investigations, United States Department of Agriculture, in cooperation with the Oregon Agricultural Experiment Station, show that *Tilletia tritici* enters the epidermis of the coleoptile of both susceptible and resistant wheat plants grown under conditions for maximum infection, but that in highly resistant varieties it develops no further. Inhibiting factors evidently are active in or just beneath the epidermis. In varieties slightly less resistant no distinction from highly susceptible varieties can be observed until the plants are about ten days

old, this period being the time required by the fungus to pass into the permanent tissues of the plant, after which the suppressive factors evidently are in action. Cytologic examination of plants of this second or slightly less resistant class when 60 days old reveals only the same percentage of infection as is visibly developed in mature plants of the same lot.

In the epidermal cells the fungus hyphae are gram-negative, but the adjacent cell walls and cytoplasm are gram-positive. The hyphae are inclosed in a sheath of undetermined nature. In the interior of the coleoptile and in the true leaf sheaths the hyphae are both inter- and intracellular, gram-positive, and produce no observable change in the adjacent tissues. The same is true in the axis of the plant except that it is strictly intercellular.

Control of stinking smut of wheat (Tilletia levis) with dust treatments. G. H. COONS.

Copper carbonate, copper sulphate and lime dusts, using heavily smutted winter wheat, have given the following results in comparison with the standard formaldehyde treatments in stinking smut control:

Treatment	Sound heads per row	Smutted heads per row	Per cent of smut	Stand per cent
Control	568	495	46.	100
Dry formaldehyde	925	29	3.	98
Wet formaldehyde	743	0	0	97
Soak and skim formaldehyde method	900	5	0.5	97
Copper sulphate and lime dust, 2 oz. per bu.	1080	42	3.7	97
Untreated	500	408	44.	100
Copper carbonate, 4 oz. per bu.	850	23	2.6	98
Untreated	640	120	15.7	100
Copper carbonate, 2 oz. per bu.	823	12	1.4	97
" " 4 " " "	801	20	2.4	95
" " 8 " " "	844	8	0.9	90
" " 16 " " "	651	0	0	90
Untreated	320	160	33.3	100
Copper sulphate and lime dust, 2 oz. per bu.	555	27	4.6	98
" " " " " 4 " " "	570	24	4.	97
" " " " " 8 " " "	630	17	2.6	93
" " " " " 16 " " "	521	23	4.2	90
Control	255	203	44.	100
Copper sulphate dehydrated, 2 oz. per bu.	526	17	3.1	85
" " " 4 " " "	460	21	4.3	80
" " " 8 " " "	550	3	0.5	80
" " " 16 " " "	500	11	2.1	80
Sulphur, superfine, 2 oz. per bu.	457	76	14.	100

Considering the heavy smut production in the controls and the marked reduction brought about by both copper carbonate and copper sulphate and lime dusts, it is believed that use of these with fairly clean grain would give satisfactory stinking smut control. Tests with oats were not satisfactory in smut control.

Modified and simplified hot-water and vapor treatments for the control of loose smut in wheat, with special reference to seed injury. V. F. TAPKE.

Experiments conducted during the past two years by the Office of Cereal Investigations, United States Department of Agriculture, involving 11 seed lots of wheat, show on an average a reduction in yields of approximately 12 per cent when the seed was treated by the modified hot-water method, which commonly is recommended for controlling loose smut. Conclusive data show that this reduction in yields is due to a high percentage of seed killing caused by the treatment when the seed coats are broken over the embryo. The modified treatment simply retards germination when the seed coats are uninjured. Practically all of the breakage in seed coats results from machine thrashing. This has been shown by soil germination experiments in which treated seed carefully hand thrashed showed little or no injury while machine-thrashed seed was severely injured. The average germination of treated seed from 25 lots of the 1922 crop was about 40 per cent less for machine-thrashed than for hand-thrashed seed.

A simplified hot-water treatment has been devised which effectively controls loose smut of wheat reducing yields. A vapor treatment also has been employed successfully.

Organic mercury seed disinfectants. W. H. TISDALE AND J. W. TAYLOR.

Organic mercury compounds have been recommended in Germany since 1914 for the control of seed-borne diseases. Since 1920 a number of these compounds, including liquid and dust treatments, produced by American chemists, and Uspulun from Germany, have been tested by the Office of Cereal Investigations, Bureau of Plant Industry, Department of Agriculture, along with formaldehyde, hot water, copper sulphate-lime, and copper carbonate, to determine their effect on germination, vigor, and smut control of the small grains. The dusts, including copper carbonate, were less effective than liquids in controlling barley and oat smuts. The most promising liquid treatments used are Chlorophol, Uspulun, Corona Compound No. 620, and Semesan. Chlorophol and Uspulun were equally efficient. Corona No. 620 in less extensive experiments was apparently better than these, while Semesan compared favorably with them. These materials caused improved germination in greenhouse and field, increased field stands, and controlled smuts excellently. Barley and oats treated with Chlorophol, the only mercury compound used on seed sown in varietal plats, yielded better than did plants from seed of the same lots treated with copper carbonate or any other treatment. Copper carbonate proved best for wheat bunt. The mercury treatments look promising for the control of barley and oat smuts.

Germination of the spores of timothy smut (Ustilago striaeformis (Westd.) Niessl). W. H. DAVIS.

Published results indicate that conditions for the successful germination of the spores of this smut parasitizing timothy (*Phleum pratense* L.), June grass (*Poa pratensis* L.), redtop (*Agrostis palustris* Huds.) and orchard grass (*Dactylis glomerata* L.) have not been understood. However, the writer has found that these spores germinate when properly after-ripened. Observations of bi-weekly germination tests continued through a period of two years may be summarized:

1. Conditions for the successful germination and the behavior of the germinated smut spores from each host are similar.

2. The smut spores pass through an after-ripening period varying from 180 to 265 days.

3. Period of germinability, 53 to 210 days; average, 70 days.

4. Nourishing solutions and decoctions are of no visible value in forcing the germination of these smut spores.

5. After-ripened spores germinate either floating or submerged in distilled water but do not germinate when placed on damp surfaces.

6. Temperatures: minimum, 10° C.; maximum, 35° C.; optimum, 22° C.

7. The fully developed promycelium may be septate and bear one branch from each cell.

8. A few promycelia bore typical sporidia at each cross-wall.

9. Spore germinations show that the parasite on each of the above hosts is an Ustilago and not a Tilletia as sometimes reported.

Mosaic and leaf roll of the potato in the northwest. GEO. K. K. LINK.

Mosaic is practically everywhere present in the Northwest, occurring in the leading varieties, Idaho Rural (generally 20–40 per cent), and Russet Burbank (10–20 per cent). The only stocks relatively free (5 per cent or less) are those introduced early into sequestered localities. During 1922 aphids were first found in potato fields after three years search. They appeared abundantly during late August and September in those northern sections considered the best sources for seed.

Infectious leaf-roll is most plentiful in an area embracing northeastern Washington, northern Idaho and western Montana, affecting primarily the Russet Burbank (15–20 per cent). It has increased decidedly during the period 1919–1922 and is spreading.

Observations (1919–1922) indicate that low humidities, high temperatures, and intense sunlight which characterize the growing seasons of the semi-arid and arid west cause not only such pronounced masking of mosaic and other virus disease symptoms, but also such marked changes in healthy plants that the symptomatology determined in the humid sections and the methods of field inspection used there are inadequate in the west. This is especially true under "dry-land" conditions. Determination of the responses of both healthy and diseased potato plants to these environmental factors is imperative before field inspection and seed certification in the west can be put on a firm basis.

Potato mosaic masking at high altitudes. H. G. MACMILLAN.

In the Rocky Mountain and other western potato growing sections the mosaic disease of potatoes has seldom appeared conspicuously in the generally characterized form. Some factor or set of factors masks the symptom of mottling. In potatoes grown at an altitude of 8000 to 8500 feet mottling is entirely absent. At lower altitudes the symptom of mottling is found intermittently. Potatoes newly infected with mosaic and grown under a louvered shelter constructed of wide strips of white cloth, and entirely open on the north side, developed conspicuous mottling, as compared with plants from the same seed tubers grown in the full sunshine and on which no mottling developed. Conditions in the shelter including temperature were practically identical with those outside, except that no sunlight fell on the plants. It is believed that the large amount of short wave-length light in the sunlight at high altitudes stimulates chlorophyll production in mosaic diseased cells, the effect being to mask the common symptoms. Some antiseptic action is possible. The life of the mosaic plants is longer under these circumstances. Non-mottled mosaic plants transferred from high to low altitudes readily develop mottling.

Spindling-tuber and other degeneration diseases of Irish potatoes. E. S. SCHULTZ AND DONALD FOLSOM.

Transmission of spindling-tuber disease, commonly designated as "running-long" or as a type of "running-out," has been obtained with tuber grafts, vine grafts, leaf-mutilation inoculation, and aphids. Symptoms are erect and spindling stalks, smaller, more erect and somewhat darker green leaves than in healthy foliage, and spindling, spindle-shaped tubers (instead of flat, oblong tubers as in healthy Green Mountains) with more numerous and more conspicuous eyes and with a smoother skin and consistency less firm than in healthy tubers. Spindling-tuber is in the leading commercial varieties in all percentages of incidence; spreads about as readily as mosaic; infects hills in part, resulting in diseased and healthy progeny from the same hill or even from the same tuber, as in mosaic and leafroll; and reduces the yield considerably. In addition to carrying mild mosaic, leafroll, and spindling-tuber, aphids transmit leaf-rolling mosaic, severe mosaic, and unmottled curly-dwarf. Leafrolling mosaic forms a curly-dwarf when in combination with spindling-tuber. Severe mosaic is more injurious and infectious, and causes current-season symptoms oftener and sooner than mild mosaic or leafrolling mosaic. If isolated from other degeneration diseases, mild mosaic strains will not acquire different symptoms. Mosaic and leafroll, together, or other degeneration disease combinations, may reduce tuber production affecting self-elimination. Transmission to healthy plants decreases as the distance from diseased plants increases, and fluctuates seasonally and regionally with aphid infestation.

Spindling tuber or marginal leaf-roll. KARL H. FERNOW.

The marginal leaf-roll disease of potatoes was recognized as a disease in 1921, when tuber units showing a large percentage of marginal leaf-roll were seen. The most striking characteristic of the disease is the elongation of the tubers which is often extreme. The vine shows an upright habit and is frequently dwarfed. The leaflets are slightly rolled at the margins, which are often crinkled, and are somewhat smaller than normal but do not show the extreme rolling which occurs in true leaf-roll. The stolons are not shortened as in true leaf-roll and there is no phloem necrosis. The examinations for phloem necrosis were made by Dr. Artschwager. The yield is considerably reduced. That the disease is transmissible is shown by the fact that among tuber units having a common ancestry some had degenerated while others were normal. A healthy plant on which a diseased scion was grafted produced a typically elongated tuber. The progeny has not been grown. The disease has been observed in Rurals, Green Mountains and Cobblers. The disease was previously mentioned by Quanjer. He noted the absence of phloem necrosis but not the elongation of the tubers.

A new host for potato mosaic. KARL H. FERNOW.

Twelve plants of the Apple of Peru, *Nicandra physaloides*, which were rubbed with crushed leaves of mosaic potato plants all developed distinct mottling. Four plants rubbed with leaves of mosaic tomato, four with leaves of mosaic tobacco, two with leaves from a mottled burdock plant and two with their own healthy leaves remained healthy. The leaves of two Nicandra plants which had become mosaic following inoculation from potato were used to inoculate two more Nicandra plants which later showed mosaic. Under favorable conditions the time elasping between inoculation and the appearance of mosaic is two weeks or less. One uninoculated plant showed mosaic at the time the first inoculations were being made. A plant which was rubbed with leaves

from a mosaic *Physalis pubescens* plant also developed mosaic. Attempts to transmit the disease back to potato have so far given negative results. The progeny of inoculated potato plants has not yet been grown.

The occurrence of protozoa in plants affected with mosaic and related diseases. RAY NELSON.

Using modern cytological methods, protozoan killing and fixing solutions and protozoan stains, an intensive study has been made of bean mosaic, clover mosaic, tomato mosaic and potato leaf-roll. Definite protozoan organisms have been demonstrated constantly associated with these diseases and are located mainly in the sieve tissues. The bean and clover organism is a biflagellate, elongated protozoan whose generic position is near Leptomonas. It apparently is a flagellate of new generic rank, since the location of the flagella is unlike that belonging to any other described genus. The organisms found in mosaic tomato plants are apparently trypanosomes, or are closely related to this genus. They have been found only in the seive tubes. Some individuals are 30μ or more in length, while very small forms are present which are less than 0.5μ wide and 6μ long. In the sieve tubes of potato leaf-roll plants, organisms have been found which more closely resemble trypanosomes than any other form. They are very variable in size, the smallest individual measured being less than 1μ wide and 12μ long. They are closely associated with the nucleus, in many cases actually coiled around it. All of the above organisms lie in a plane parallel to the longer axis of the host cell and have been demonstrated only in longitudinal sections.

Intracellular bodies associated with the rosette disease of wheat. H. H. MCKINNEY, SOPHIA H. ECKERSON, AND R. W. WEBB.

Microscopic studies on the rosette disease (formerly called take-all, so-called take-all, and foot-rot) of wheat revealed unusual intracellular bodies in the basal tiller tissues of plants showing early stages of the disease. These bodies also were found in wheat leaves showing a mosaic-like mottling which occurs not entirely on rosetted plants and on adjacent plants free from rosette and on plants of certain varieties which are apparently immune from the rosette disease. They have not been found in plants free from rosette and the mosaic-like mottling.

These bodies may be closely applied to the host nucleus, sometimes completely surrounding it, or they may be separated from it. They range in size from smaller to considerably larger than healthy wheat nuclei. In shape they vary from spherical to irregular and elongated forms. While these bodies resemble in certain particulars those described by Kunkel in connection with corn mosaic, they resemble more closely those described by Iwanowsky in connection with tobacco mosaic and by Lyon in connection with the Fiji disease of sugar cane.

The symptoms of the rosette disease of wheat bear certain resemblances to the symptoms of corn mosaic as described by Kunkel. (Cooperative investigations by Wis. Agr. Exp. Sta. and Cereal Investigations, B. P. I., U. S. Dept. Agr., with informal cooperation from Dr. C. A. Kofoid, University of California and from the Thompson Institute for Plant Research.)

Intracellular bodies associated with a "mosaic" of Hippeastrum johnsonii. H. H. MCKINNEY, SOPHIA H. ECKERSON, AND R. W. WEBB.

Studies made of free-hand sections and embedded material from the leaves of *Hip-*

peastrum johnsonii Bury, showing a mosaic-like mottling, revealed interesting intracellular bodies which were usually associated with the host nuclei.

In certain respects these bodies resemble the intracellular bodies found by the authors in connection with the rosette disease of wheat, but in general they are more nearly like those described by Kunkel in connection with corn mosaic, and apparently like those described by him in connection with the mosaic of *Hippeastrum equestre*.

As yet these bodies have not been found in the normal green areas of the leaves. In mottled tissue the bodies are found in the epidermal cells or in cells just below the epidermal layer. In the material thus far examined the bodies are present in about 5 per cent of the cells.

The nature of these bodies and likewise their exact relation to the mosaic-like leaf mottling is not known.

(Cooperative investigations by Wis. Agr. Exp. Sta. and Cereal Investigations, B. P. I., U. S. Dept. Agr.)

Temperature studies in mosaic diseases. B. T. DICKSON.

The roots of well-grown healthy and mosaic diseased tobacco plants were maintained in a constant temperature chamber at 37.5° C. (99.5° F.) while the stems and leaves were kept in an atmosphere of 21° C. (70° F.). They were given water at 37.5° C. daily. An ascending temperature gradient from soil to stem growing-point was thus developed. In 5 days the developed leaves became much darker green, especially noticeable in the hypoplastic areas of diseased leaves. In 10 days hypoplastic areas were dead in the lowermost leaves, but newly-developed leaves still showed marked color differentiation. Healthy and newly-inoculated seedlings were also tested. The first new leaves showed color differentiation, but were darker than at ordinary sap temperature. Later leaves were poorly developed but there was no cessation of infectivity.

Temperature studies in mosaic diseases. B. T. DICKSON AND E. G. HOOD.

The authors are making a series of tests to determine whether there is subnormal or supernormal temperature in mosaic-diseased tobacco, potato, bean, clover, etc. plants. Thermocouples of copper-constant wire with Type K Potentiometer, enclosed lamp and scale Galvanometer and Weston Standard Cell were used. The plants were tested in a constant temperature chamber. No constant temperature difference has been obtained as yet. More delicate couples are under construction and the tests will be continued.

Mosaic disease of sweet potato.—GEORGE F. WEBER.

Recent observations and experimental data concerning sweet potatoes show a diseased condition similar in many ways to the mosaic of other plants. Diseased sweet potato plants were first observed in a ten acre field where actual counts showed six per cent of the plants affected. The yield is reduced to less than ten per cent of the normal. The characteristic symptoms are: Internodes decidedly shortened; thus the nodes bearing leaves are close together, affected plant showing a decided rosette appearance. The petioles are somewhat shorter and thicker than those of normal plants. The petiole at point of union with the blade is often flattened. The larger veins branch out into the blade abnormally suggesting fasciation and appear much wider and more prominent than the veins in normal leaves. The tissue between the veins is of a uniform green color, decidedly raised or sunken, forming pouch-like areas. There is no mottling, in the sense that leaves of cucumber and tobacco plants are mottled by

mosaic. The blades are crinkled along the edges, curled backward and in severe cases malformed. Twenty healthy plants were inoculated in various ways with the juices extracted from twelve different diseased plants but symptoms of the disease did not develop.

The location of the crown-gall organism in its host tissues. A. J. RIKER.

In inoculation studies of crown-gall on tomato stems it was observed that needle wounds immediately released liquid which flooded the neighboring intercellular spaces and formed water-soaked areas about the punctures. As the galls developed, they were found to coincide closely in outline with these water-soaked regions. Galls of different sizes were induced experimentally by varying the sizes of the inoculating needles and consequently those of the water-soaked areas. Expressed tomato sap was found to exert a positive chemotactic influence on the bacteria. They migrated through water-soaked tissue and produced galls several centimeters from the point of inoculation. The bacteria were observed consistently *in situ* in an intercellular position both in paraffin and free-hand sections from five series of inoculations which were examined at two day intervals until distinct hyperplasia, hypertrophy, and vascular elements developed. They appeared to be present in larger numbers than has previously been supposed and to exert their stimulating influence from a position between the cells.

Some morphological responses of the host tissues to the crown-gall organism. A. J. RIKER.

Studies of crown-gall made on tomato have shown that the causal organism begins its relations with the host in the liquid released by the wound. This liquid was found to flood the neighboring intercellular spaces. From this position the bacteria stimulated some of the nearer host cells to divide into smaller cells forming a region of hyperplasia. Beyond this region the cells often reacted by swelling to form a region of hypertrophy. When the bacteria were distributed through the intercellular spaces for some distance in a more or less straight course, the subsequent division of the surrounding cells formed a "tumor strand." When inoculations were made near the growing tips of sweet pea and sunflower plants which have condensed buds, occasionally "secondary galls" developed at some distance from the points of inoculation while "tumor strands" developed in the intervening region. In such plants as those mentioned the flooding of the intercellular spaces for a few millimeters in the region of elongation would enable the bacteria to separate themselves from the point of entry by a number of internodes. When the process of elongation took place, the secondary galls would be separated from the point of inoculation by distances varying with the length of the internodes. Heavy infection near the growing tip may, however, prevent the normal elongation of the internodes.

Time of apple blotch infection for 1922 in southern Pennsylvania. R. C. WALTON AND C. R. ORTON.

Bagging experiments on unsprayed Smith Cider trees in Adams County, Pennsylvania, prove that infection by *Phyllosticta solitaria* started very early in the spring of 1922. Young apples bagged continuously from May 23 (17 days after the petals fell) until August showed 64 per cent blotch, indicating that initial infection occurred prior to May 23. Infection on petioles and leaves was first noticed on the bagging date (May 23) but was not noted on the unbagged fruit until June 13 when the largest spots measured 4 mm. in diameter. Because of the slow development of the disease, these spots must have been visible for at least a week prior to this date.

According to Roberts, "*Phyllosticta solitaria* grows slowly and is not perceptible on the fruit until 3–6 weeks after infection has taken place." If this holds true for Pennsylvania conditions and granting that fruit infection was visible by June 6, then according to Roberts the latest date when infection occurred was about May 16 which is only 10 days after the date of petal fall. This brings the time of probable initial infection on fruit at least 10 days prior to the time usually recommended for applying the first spray.

New aspects of apple blotch control. MAX W. GARDNER AND H. S. JACKSON.

In Indiana, apple blotch in the canker form is introduced into nurseries on the seedlings and into young orchards on the nursery stock. Cankers occur abundantly on budded seedlings both above and below the bud and on susceptible stocks such as Northwestern. Scions from susceptible varieties may carry the disease. Trunk and limb cankers are of common occurrence in young orchards of such varieties as Oldenburg and it has been found that these cankers can be easily cut out with a sharp knife in early spring without injury to the underlying cambium. Healing occurs rapidly and no wound dressing is necessary. There is little danger of reinfection if all of the discolored bark is removed and if the cut is made at least a centimeter in advance of the visible margin of the canker, particularly at each side. Thorough-going canker eradication combined with the blotch sprays to prevent new cankers is advisable in young orchards. The application of blotch sprays in nurseries and the use of blotch-free stocks and scions is much to be desired.

Apple scab control in Massachusetts. WEBSTER S. KROUT.

Under conditions most favorable for scab infection, almost perfect control of apple scab on the McIntosh variety was obtained by the writer. Investigations have extended over the last two years and have been along two lines: (a) a study of the causal fungus, *Venturia inaequalis*, and (b) a study of control measures. Each year the time of ascospore discharge has been determined in order that the pink application might be timed correctly. Temperature, relative humidity and rainfall records have been accurately recorded for correlation with the occurrence and prevalence of scab.

Field work was carried on in six different orchards, and data were taken from over 100,000 apples. Best results were obtained with a 3–10–50 home-made Bordeaux mixture for the pink application, followed by liquid or dry lime-sulphur for succeeding sprays. The results indicate that dry lime-sulphur is as effective as the liquid form against scab.

In 1922 dusts were practically as effective as the spray materials. Sulphur dusts and copper-lime dusts were tested. The former was more satisfactory than the latter as it did not russet the fruit or burn the foliage.

The importance of the Phoma stage of Mycosphaerella rubina causing spur blight of raspberries. A. G. NEWHALL.

The imperfect stage of *Mycosphaerella rubina* (PK.) Jacq. has been proved to be a normal part of the life cycle of this pathogene. In the latitude of southern Minnesota and New York the perithecia mature in the spring and discharge their spores by the middle of June. Mature pycnidia have been found in primary cane lesions the last week of June and in leaf spots the first week of July. This Phoma stage plays an important role by initiating secondary cycles throughout the remainder of the growing

season. The connection between the perithecial and pycnidial stages of *Mycosphaerella rubina* has repeatedly been demonstrated in single spore cultures on Melilotus stems. Furthermore, suspensions of ascospores inoculated into young raspberry canes likewise gave characteristic lesions in which the Phoma stage developed.

Aerial galls of peach. J. A. McCLINTOCK.

In the fall of 1920 peach seeds were planted on a piece of land 125 yards wide and 350 yards long which had been cleared of oak timber in 1916. This land is joined on three sides by standing timber mostly oak, some of which have large galls on their trunks.

The peach seedlings were budded June 25–30, 1921, and 10 days later they were topped at the bud. About 4000 trees out of a total of 80,000 developed galls at the wound made by topping. The roots were free from galls. In the fall of 1921 peach seed were again planted on this land and in 1922 budded and topped about the same time as in 1921. A careful search November 10, 1922 disclosed three trees bearing aerial galls and only two of these were at the wound made by topping. The growing season of 1921 was wet throughout while in 1922, it was dry. The grower thought the peach galls must have come from the galled oaks. Cultural studies of these peach galls are being made.

Melanose and stem-end rot of citrus fruits. O. F. BURGER.

Melanose is caused by the fungus *Phomopsis citri* Faw. This fungus lives in the dead wood, and in the spring of the year the spores are washed down on the fruit and leaves by the rain, where they germinate and cause the common form of russeting known as melanose. Leaves four weeks old are immune to the attack of the fungus. In preliminary work I found that the grapefruit become immune about the middle of May. When the fruit begins to ripen they are again attacked by the fungus, which at this time causes a decay of the fruit known as stem-end rot. This decay always occurs after the abscission layer is formed. The abscission layer forms a natural opening for the fungus to enter. It has been determined that the fungus cannot penetrate the rind. By inoculating green or ripe fruit with *Phomopsis citri* Faw. decay takes place. In March and April, 1922, spraying experiments were begun to control melanose. Trees were sprayed with a 3–3–50 Bordeaux solution, plus 1 per cent of oil emulsion, ten to twenty days after the blossoms dropped. All the data have not been collected; but what evidence we have indicate that melanose is controlled by this spray.

Foreign studies of white pine blister rust. PERLEY SPAULDING.

Eight months have been spent in the various European countries studying the white pine blister rust. Except in Switzerland and Germany, *Pinus strobus* occurs in relatively small numbers and is really an ornamental rather than a timber tree. Moir in 1920 added *Pinus koraiensis* to the known white pine hosts of *Cronartium ribicola*, leaving but four species not known to be attacked. Since then *P. strobiformis* has been inoculated in the greenhouse and *P. balfouriana* has been doubtfully reported as infected in Europe. During the present studies *P. albicaulis* was found in England bearing pycnia and one aecium. The oldest *P. strobus* seen in an infected area were in Switzerland and ranged upwards to 118 years in age. Trees of this species were seen in various countries, ranging in age from 4 to 118 years, that were killed or being killed by the blister rust. There is not the slightest doubt that the largest and oldest trees can and will be killed by it. The older trees are killed by girdling of the trunk in the lower part of the crown. Exuded pitch is much more conspicuous on the cankers in Europe than in America.

White pine blister rust in the Northwest. HAVEN METCALF.

The oldest infected (1910) pine wood found at Vancouver, B.C., indicates that Vancouver was the place first infected. Records are clear as to importion of *Pinus strobus* from Europe to Vancouver at this time. On the other hand it is not impossible that there were independent introductions of the disease on Ribes as well as pine at other points, both in British Columbia and in Washington. Both hosts were introduced independently at many places before quarantines were in effect in either the United States or Canada, and it would be strange if some of these introductions were not diseased. The disease now extends north (on pines and Ribes) to the limits of *Pinus monticola*, east (on pines and Ribes) to Beaton, B. C., and south (on Ribes) to within 25 miles of the Columbia River at the coast, thus occurring within a triangle of country 425, 320 and 315 miles on a side. The heaviest spread has been northward, due to climatic conditions and greater abundance of cultivated black currant in British Columbia. Serious local damage to *Pinus monticola* has already occurred. This host appears to be somewhat more susceptible than *P. strobus*, but aside from this fact the disease apparently behaves much as in the East.

White-pine blister rust infection through grafted roots. MINNIE W. TAYLOR.

Recent field observations have raised the question as to whether the white-pine blister rust (*Cronartium ribicola* Fischer) might spread from diseased to healthy trees through the roots. Abundant well-developed aecia of *Cronartium ribicola* were found on a root of *Pinus strobus* growing under several inches of leaves and loam. Twelve other roots were examined to determine how far infection might extend down or along the roots. The roots ranged from 5 inches to 28 inches in length and hyphae and haustoria occurred in eight of them, extending from 4¾ inches to 16 inches down the root. Pycnial layers were observed in four of the roots, the lowest depth being 10 inches. Grafted roots occurred in two out of three specimens collected to show this feature especially, and in two out of five specimens selected for determining the extent of infection down the root. The grafted roots of four pairs of trees were studied; in each case one of the paired trees was infected. Hyphae and haustoria were found in the graft tissue in three cases. In two of the specimens the infection extended through the graft tissue well up the trunk and down into the root of the second tree, thus supporting the original theory that infection might spread by means of grafted roots.

Studies on the aecial stages of Cronartium ribicola and Cronartium occidentale. REGINALD H. COLLEY AND MINNIE W. TAYLOR.

Morphological differences in spore markings and margins are slight but consistent; the peridial cell arrangement and markings are characteristic; and the "concomitant cell," an element midway between the spore and the peridial cell in *occidentale*, appears to have no homologue in *ribicola*. Concomitant cells measure (500) $17.90 \pm .072 \times 21.96 \pm .078$, standard range $15.52 - 20.28 \times 19.36 - 24.56$. The two species can be readily separated on a basis of morphological and dimensional differences.

Statistical analysis of *Cronartium ribicola* and *Cronartium occidentale*

Aeciospores (2000)*	M.	$18.1 \pm .03 \times 24.1 \pm .04$	$19.1 \pm .04 \times 26.8 \pm .05$
	R.	$16.0 - 20.2 \times 21.6 - 26.7$	$16.7 - 21.5 \times 23.7 - 29.9$
Aeciospore markings, surface view (500)	M.	$1.1 \pm .07 \times 1.5 \pm .09$	$1.3 \pm .08 \times 2.3 \pm .2$
	R.	$.9 - 1.3 \times 1.2 - 1.8$	$1.1 - 1.6 \times 1.6 - 2.9$

Peridial cells, outer layer, section view (500)	M.	29.2 ± .1 × 42.2 ± .2	19.1 ± .1 × 27.4 ± .1
	R.	24.9 — 33.5 × 35.0 — 49.3	15.6 — 22.5 × 23.2 — 31.7
Peridial cell walls, outer wall (500)	M.	6.8	4.7
	R.	5.3 — 8.2	3.7 — 5.6

* = Unites measured, M. = mean, R. = standard range based on coefficient of variability.

A noteworthy case of resistance to the chestnut bark disease. J. FRANKLIN COLLINS.

Records and photographs of a sprout of an American chestnut tree in Pennsylvania which in 1912 was 1.2 inches in diameter and showed several places badly diseased by the chestnut bark disease fungus. In ten years this sprout had increased to approximately 7 inches in diameter, and certain lesions caused by the disease, which were very evident in 1912, showed little external evidence of disease in 1917 and later. The sprout always was and still is badly diseased in various places. The fact that a sprout of American chestnut but little more than an inch in diameter, and apparently girdled at the base in 1912, should have survived for ten years and increased to 7 inches in diameter seems noteworthy. Lantern slides will show views of the base of the sprout taken in 1912, 1917, 1920 and 1922.

The Melanconis disease of the butternut. ARTHUR H. GRAVES.

This is characterized in its first stages by the appearance of dead limbs besprinkled with small black acervuli of the causal fungus, *Melanconis juglandis* (E. & E.) comb. nov. Occasionally the acervuli develop spore horns, but are usually rounded or wartlike, and in wet weather like drops of thick ink. This conidial stage has been known as *Melanconium oblongum* Berk. The ascospore stage, which may appear later near these same pustules, has been known as *Diaporthe juglandis* E. & E., but by culture work this is now definitely proved to be the perfect stage of *Melanconium oblongum* Berk. Inoculation experiments, extending over a period of more than four years, have conclusively demonstrated that the fungus is a weak parasite. Entering usually through small twigs by way of a wound, the mycelium grows slowly down through the wood—faster if the tree is already weakened—to the main branch and finally to the trunk. Ordinarily the progress of the disease is so slow that the leaves fall one by one, not producing any striking wilting or blighting effects. In final stages affected trees have a marked stag-headed aspect. Diseased branches should be pruned off promptly some distance below apparent infection and the wounds tarred over or painted. After the fungus has penetrated the trunk no remedy is practicable.

The relation of an undescribed species of Pestalozzia to a disease of Cinnamomum camphora Nees & Eberm. NATHANIEL O. HOWARD.

Investigations have been made recently to determine the relation of fungi to a disease of *Cinnamomum camphora* Nees & Eberm., a malady which seriously threatens the production of raw camphor in this country. The disease is caused primarily by a thrips, *Cryptothrips floridensis* Watson. Certain camphor growers, however, regard the thrips injury as merely incidental to the attacks of a fungus, the latter being the really destructive organism. An undescribed species of Pestalozzia was found to be quite constantly associated with the thrips injury. Moreover, evidence was obtained indicating that the thrips is partly responsible for dissemination of the Pestalozzia spores. Inoculation experiments, however, conducted in the greenhouse upon camphor

plants entirely free from thrips indicate that, under these conditions at least, this *Pestalozzia sp.* is unable to attack the healthy tissue, but develops readily in dead portions of the host. It appears, then, that this fungus is a saprophyte or, at the most, a weak, wound-parasite upon *Cinnamomum camphora* Nees & Eberm. and that control of the disease lies in the elimination of *Cryptothrips floridensis* Watson.

Progress in barberry eradication. F. E. KEMPTON.

In the barberry eradication campaign conducted cooperatively for five years by U. S. Department of Agriculture and 13 north-central States, marked progress has been made. During 1922, the survey covered 200 counties. This includes 16 counties in Minnesota and one in Iowa surveyed on State funds. In these counties, 186,672 bushes were located on 5,278 properties, and 696,517 bushes were removed from 5,799 properties. Of 275 counties previously surveyed, 201 were completely resurveyed in 1922, and 84,142 sprouts were found and removed. Experiments on chemical methods of eradication, begun in September, 1921, have yielded highly important results. Bushes properly treated with salt or sodium arsenite die without sprouting. Investigations on the distribution of rust spores by air currents are being conducted cooperatively with the War Department Air Service which furnishes airplanes and pilots.

During the five years, 1918–1922, practically all cities and villages of the 13 States have been covered once and resurveyed in part, and 475 counties have been completely covered. This includes 40 counties surveyed on funds furnished by States. In the 5 years, 2,066,541 bushes have been found in cities and villages and 3,740,102 on farms, making a total of 5,806,643 bushes found, of which 5,140,343 have been removed.

Eradicating the common barberry by means of chemicals. NOEL F. THOMPSON.

In connection with the cooperative barberry eradication campaign of the U. S. Department of Agriculture and 13 north-central States, it has been found that abundant sprouting from root fragments occurs under certain conditions when the bushes are dug. In the rolling, more or less wooded portions of these States, hundred of thousands of escaped bushes have developed from seeds carried by birds or animals. Under these conditions and especially in well-trained, more or less alkaline or limestone soils, root fragments sprout most abundantly. For these reasons the effectiveness of chemicals in killing the bushes is being studied. While the experiments have not been completed, certain promising results have been obtained.

More than forty different chemicals have been studied. Of these, two seem satisfactory from the standpoint of effectiveness, cost, and availability. These are salt (sodium chloride) applied at the rate of about 10 pounds per bush of average size, and a solution of sodium arsenite (1 lb. to 5 gal. water) applied at the rate of two gallons per bush. Salt may be applied at any period of the year. The sodium arsenite is effective when applied throughout the growing season, but its action when applied in the late fall and winter is not yet fully determined.

Pathological morphology of durum wheat grains affected with "black point." WANDA WENIGER.

For many years a disease of durum wheat, particularly of Pentad (D5), Monad (D1), Kubanka, and Arnautka, has occurred in North Dakota. The disease is characterized by "black pointed" grains, in which the embryo end is typically creosote colored. Some kernels are decidedly shrivelled as the result of early infection, but the majority are not noticeably underweight. Poor germination is common, and frequently a destructive

seedling blight develops. During the past four years the writer has isolated from hundreds of blackpointed grains and blighted seedlings a fungus similar to *Helminthosporium sativum* P. K. & B. As high as 30 per cent of grains have been found internally infected. Sections of many grains show that the mycelium invades the pericarp and testa, is present between these layers and the embryo, and may invade the embryo itself. If moisture is supplied and germination begins, the mycelium forms lesions in rootlets and plumule before emerging from the grain. The aleurone and endosperm are subsequently attacked, and spores are frequently found in the lesions. In roots and shoots of young seedlings the fungus forms lesions in the cortex and eventually penetrates the vascular region, causing a rotting off of the organ. (This work is a continuation of investigations carried on at, and previously reported from, the North Dakota Experiment Station.)

Some fungi causing black point of wheat. A. W. HENRY.

The following fungi were isolated from black pointed kernels of Marquis wheat grown at St. Paul in 1920: *Helminthosporium sativum* P. K. B. from 73.5 per cent of all kernels yielding fungi; *Helminthosporium sp.* from 3.8 per cent; *Brachysporium* from 3.8 per cent; *Alternaria* from 10.6 per cent and other fungi from 8.3 per cent. *Helminthosporium sativum* was also isolated from black pointed kernels from various parts of the United States and Canada. Cultures of *Helminthosporium sativum* isolated from barley, wheat and rye produced abundant black pointing of the embryo ends of immature wheat kernels, inoculated in the greenhouse at Saskatoon, Saskatchewan (1919–20). Inoculations were made in the greenhouse and in the field at St. Paul during the past summer with cultures of the above mentioned genera as well as several other fungi also isolated from wheat seed. The following caused black point: *Helminthosporium sativum* 53.5[1] (20.5[2]), *Helminthosporium sp.* 42.3 (13.6), *Brachysporium* 23.9 (8.9) and *Stemphylium* 23.3 (9.3). Although plump black pointed kernels frequently germinate well, as high as 11 per cent in the greenhouse and 50 per cent in the field, have failed to produce plants, compared with controls from normal seeds.

Aecial stages of the leaf-rust of barley, Puccinia simplex, and of rye, P. dispersa, in the United States. E. B. MAINS AND H. S. JACKSON.

Cultures made in the spring of 1922 from overwintered telia of the leaf-rust of barley collected in Virginia and Washington gave heavy infection both in the greenhouse and field, on Star-of-Bethlehem, *Ornithogalum umbellatum*. This confirms the results obtained by Tranzschel in Russia in 1914. There is a possibility that Star-of-Bethlehem, in sections of the country where it has become established as a weed, may be of importance in spreading this rust.

Cultures in 1919 and 1922 from leaf-rust of rye collected in Indiana, Wisconsin, Kansas, Nebraska and Washington have given aecia on *Anchusa officinalis*. Other Boraginaceous hosts used have remained uninfected except *Nonea rosea*, which showed a few pycnia only, agreeing with the results obtained by Erikson and others in Europe. The telia of a number of the collections of this rust, although germinating, failed to give infection under greenhouse conditions, thus possibly indicating the existence of other

[1] Per cent black point in the greenhouse.
[2] " " " " " " field.

races. Aecia of this rust have been found occurring naturally for the first time in this country, on *Anchusa capensis*, a species grown as a border plant at Lafayette, Indiana. (Cooperative investigation between the Purdue Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Dept. Agriculture.)

Variations in the length of spores of Helminthosporium sativum P. K. & B. under different conditions of growth. LOUISE DOSDALL AND J. J. CHRISTENSEN.

Subcultures from a single spore isolation of *Helminthosporium sativum* were grown on potato-dextrose agar at various temperatures and on sterilized barley heads and fresh barley leaves at 24° C. Five hundred spore length measurements of each subculture were made. On potato-dextrose agar at 18, 24, and 28° C. the differences in the mean length were insignificant but the range of variation was considerable. At 32° C. the range was practically the same as at 14° C. but the spores were shorter. The most striking differences were obtained on the different substrata. On potato-dextrose agar the mean length was 65.7 μ, on the sterile barley head 67.7 μ, and on the fresh leaves 83.1 μ. The length of the spores was most uniform on the leaves. A similar study was made of a second strain of the fungus and the results were even more striking. On two different, but similarly prepared, lots of potato dextrose, the mean length of the spores was 57.7 and 33.0 μ, respectively, while on sterilized wheat heads it was 76.6 μ. The variability of spore size of *Helminthosporium sativum* is so great that careful comparative studies only can be a proper basis for determination.

The influence of soil temperature and moisture on the development of seedling blight of wheat and corn caused by Gibberella saubinetii (Mont.) Sacc. JAMES G. DICKSON.

Greenhouse and field experiments conducted during the past three years have demonstrated that wheat and corn seedlings become susceptible to the wheat scab parasite only when grown under unfavorable environmental conditions. Wheat seedlings blight when grown in a comparatively warm soil, about 12° C.; while corn blights when grown in a cool soil, below 20° C. The response to soil moisture is the same for both plants. Wheat and corn seedlings both blight when grown in fairly dry soil regardless of the temperature at which the soil is held. The results, therefore, indicate that in this case, at least, disease resistance and predisposition to disease may be largely dependent upon environmental conditions under which the plant is developing.

(Cooperative investigations by Wis. Agr. Exp. Sta. and Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

The influence of soil temperature and moisture on the chemical composition of wheat and corn and their predisposition to seedling blight. S. H. ECKERSON AND JAMES G. DICKSON.

Controlled temperature and moisture experiments with wheat and corn seedlings indicate marked differences in chemical composition of seedlings grown under different soil temperature and moisture conditions. These differences apparently explain the variation in their susceptibility to seedling blight produced by *Gibberella saubinetii* (Mont.) Sacc. Wheat seedlings grown at low soil temperatures are high in available carbohydrates and low in available nitrogen. The cell walls, even in early seedling stage, are cellulose, soon impregnated with lignin. Wheat seedlings grown at high soil temperatures have little or no available carbohydrates and are high in available nitrogen. The cell walls are composed of pectic materials, cellulose being absent until after photosynthesis begins.

The composition of corn seedlings at low and high soil temperatures is the reverse of that for wheat.

In the invasion of coleoptile and coleorhiza of seedlings, the parasite penetrates the walls of pectic materials apparently with little resistance and is both inter- and intracellular, whereas, it penetrates the cellulose walls slowly, digesting the middle lamella and thus remaining intercellular. All gradations between these two types of penetration occur in the intermediate soil temperatures.

(Cooperative investigations by Wis. Agr. Exp. Sta. and Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

The production in culture of the ascigerous stage of Fusarium moniliforme. GRACE O. WINELAND.

For two years, the behavior of a number of single spore cultures of *Fusarium moniliforme* Sheldon isolated from corn has been under observation, particularly for the development of an ascigerous stage. Some of these cultures have produced perithecium-like bodies under certain conditions, but no combination of environmental factors has been found that would induce the development of mature perithecia. Recently, mature perithecia of the Giberella type have been produced in abundance, but only by combining two strains of the fungus. In one experiment, strain Y 15, alone, produced only perithecium-like bodies, but, when it was combined with Y 29 or S 1, mature perithecia developed along the line of contact of the two strains in a majority of the tubes and plates inoculated, while Y 29 and S 1, separately or in combination, produced neither perithecium-like bodies nor perithecia.

Single germinating ascospores, from the Y 15 and Y 29 combination, produced microconidia in chains and 3-septate macroconidia typical of *Fusarium moniliforme.*

The strains mentioned differ somewhat morphologically, but all come within the limits of the new section Moniliform established by Sherbakoff.

(Cooperative investigations by the Wis. Agr. Exp. Sta. and Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

Influence of temperature on the morphology of Fusarium spores. HELEN JOHANN.

Experiments with the study of Fusaria indicate that the temperature at which the fungus is grown may affect the size, shape, and septation of the macroconidia. Cultures of a species representative of the section Roseum, whose optimum temperature for vegetative growth lies between 18° and 24° C., produce sporodochia in which 5-septate conidia predominate, averaging in size 62.2 by 3.4 μ when grown on various media in the laboratory at about 22° C. Under such conditions few 6- and 7-septate conidia are found. In similar transfers subjected to temperatures of 10° to 14° C., other conditions, except light, being the same, the spores are normal, but broader and less curved and a much higher percentage are 6- and 7-septate. The 6-septate conidia from these cultures average 67.25 by 4.32 μ. The effect of absence of light at low temperatures has not yet been determined. The presence or absence of diffuse light at room temperature appears to be comparatively unimportant.

Preliminary experiments with other sections of the genus Fusarium indicate that modification of the macroconidia may be obtained there also, although the results are less striking.

(Cooperative investigations by Wis. Agr. Exp. Sta., and Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

The pathogenicity of Fusarium moniliforme Sheldon on cereals. A. W. HENRY.

Single spore cultures of *Fusarium moniliforme*, isolated from wheat seed from Missour and from wheat sick soil at University Farm, St. Paul, Minnesota, proved virulently pathogenic to wheat (spring and winter), barley, field corn and sweet corn and also attacked rye and oats. Both cultures killed wheat seedlings growing on nutrient agar in large test tubes. They also killed or stunted wheat plants growing in sterilized soil inoculated with the organism in the greenhouse. The roots were rotted and the basal portion of the stems were sometimes attacked. The fungus was easily reisolated. On potato-dextrose agar, comparatively few macroconidia were produced but long chains of microconidia were abundant. Both spore forms were produced in abundance when moist sterilized wheat seed was inoculated either with cultures from single microconidia or from single macroconidia. The culture isolated from wheat seed and that from the soil differ slightly but both correspond closely with the description of *Fusarium moniliforme* Sheldon. Both cultures grew slightly between 5 and 7° C. and between 36 and 36.5° C. The optimum temperature for growth apparently lies near 30° C.

Corn root, stalk, and ear rot disease investigations in Kansas: Report of progress 1922. L. E. MELCHERS AND C. O. JOHNSTON.

Varieties of white corn used in the investigations show the presence of an abundance of *Fusarium moniliforme*, while only occasionally a trace of *Diplodia zeae* and even less of *Gibberella saubinetii* occurs on the germinator. Penicillium, Rhizopus, and Aspergillus are much more common than Diplodia and Gibberella. *Fusarium moniliforme* is by far the most common and occurs to a greater or less extent on over 95 per cent of all the ears so far tested. This organism occurs externally on the grain in apparently 50 per cent of the cases. Up to the present no noticeable correlation can be seen between the occurrence of seedling injury on the germinator by *F. moniliforme* and the symptoms of root, stalk, and ear rot as it occurs in the fields of Kansas. These data have been taken chiefly from strains of corn that have been selfed for two or more seasons.

The occurrence of Fusarium and other "molds" on corn in Kansas as shown on the germinator is apparently not in itself sufficient or completely reliable to use as a basis for selecting or eliminating seed corn under Kansas conditions in view of our present knowledge.

(Cooperative investigations by Kansas Agr. Exp. Sta. and Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

Relation of environment to infection of corn seedlings by Diplodia zeae (Schw.) Lev. HELEN JOHANN, JAMES G. DICKSON AND GRACE WINELAND.

Five series of experiments conducted in the Wisconsin temperature tanks indicate that *Diplodia zeae* does not cause a destructive seedling blight of corn when healthy seed is inoculated with spores or mycelium and the seedlings are grown under favorable conditions. One series under early summer conditions and in medium wet soil showed no evidence of disease. In contrast, inoculated seedlings grown in large test tubes are killed in about two weeks. The fungus is capable of attacking the mesocotyl, especially under extremely high or low soil moisture conditions at temperatures ranging from 24° to 32° C. which includes the optimum temperature for the growth of the fungus. In wet soil at 28° C., 63 per cent of the plants showed severe browning of the mesocotyls. These plants were not much stunted but leaned considerably due to their weakened

mesocotyls. The effect of this type of injury on later development is not known as the plants were not carried far beyond the seedling stage. (Cooperative investigations by Wis. Agr. Exp. Sta. and Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

Helminthosporium disease of rice. G. O. OCFEMIA.

In an earlier abstract (Phytopathology **12:** 34. 1922), the disease caused by *Helminthosporium oryzae* Breda de Haan was called "Sesame spot disease of rice." The change of title is made in order to make the disease distinctly that of the rice and avoid possible confusion with a disease of *Sesamum indicum* L., caused by *Helminthosporium sesameum* Sacc.

Experiments were conducted on the relation of soil temperatures to germination of certain Philippine low land and up land rices and the production of disease from artificial inoculations. Rice germinated two to three days after sowing at 36° C. and 32° C., three to four days at 28° C., four to five days at 24° C., five to six days at 20° and 40° C., and eight to fourteen days at 16° C., with soil moisture 25 per cent of the water holding capacity of 27.5 per cent. Subsequent growth of seedlings is best at soil temperatures of 28° to 32° C. Infection takes place in soil temperatures from 16° to 36° C., but is most severe at 28° to 32° C. Certain Philippine and Louisiana low land rices sprout under 10 to 20 centimeters of water at temperatures of 20°, 24° and 28° C., in two weeks. Inocula applied externally on flooded rice did not produce infection. The causal fungus produced symptoms of the disease in artificial inoculation on 31 species of 23 genera of grasses.

Disease of flax caused by a species of Rhizoctonia. W. E. BRENTZEL.

A destructive and apparently undescribed disease of flax has been observed in a number of fields in eastern North Dakota. The disease occurred in somewhat definitely limited areas from a few feet across to more than an acre in extent. In these areas, practically every flax plant was infected. On individual plants, the infection first appears on the roots as small brown lesions just beneath the surface of the soil. Later, these lesions enlarge and extend upward to the cotyledonary leaves and also downward, covering an area measuring from 1 to 4 or 5 centimeters in length. In the later stages of the disease, the affected cortical portion of the stem is reduced to a dry pulp which sometimes breaks and splits in such a manner as to give a ragged appearance. The fungus enters the pith and spreads, but the extent of penetration has not been determined. The plants wither and die prematurely, taking on the general appearance of "wilt." The associated fungus apparently belongs to the genus Rhizoctonia. The fungus is pathogenic on flax but non-pathogenic on various other plants thus far inoculated. Its minimum, optimum, and maximum growth temperatures in culture are about 13, 26, and 35° C., respectively. (Cooperative investigations by the N. Dak. Agricultural Experiment Station and office of Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

A disease of flax not previously reported in the United States. W. E. BRENTZEL.

During the past 4 years a disease of seed flax has been observed in North Dakota, which develops characteristic greenish-yellow to dark brown mottling on the stems, leaves, and capsules. During the past season the same disease was observed on fiber flax in Michigan by Mr. R. L. Davis, who sent specimens for identification. The disease is very similar to if not identical with that found in South America caused by *Phlyctaena linicola* Speg. The lesions on the stems vary in size and shape, depending

on the stage of development. At first they appear as dots, then lengthen and later widen until they extend around the stem. They may cover an area of one half to several centimeters in length, leaving irregular-shaped bands of green between lesions. The spores of the associated fungus are borne in pycnidia and are hyalin, practically cylindrical, straight or slightly curved, and measure about 1.5 to 3.0 by 21 to 31 μ. Artificial inoculations on different varieties of flax indicate that certain varieties are very susceptible, while others are somewhat resistant. (Cooperative investigations by the N. Dak. Agricultural Experiment Station and Office of Cereal Investigations, B. P. I., U. S. Dept. of Agr.)

Dutch potato varieties resistent to wart disease and internal brown spot. J. CORTWIJN BOTJES AND H. M. QUANJER.

The varieties tested for resistance to the wart disease were first grown during a series of years in isolated rows in order to free them through selection from leaf-roll, mosaic and other of the so called deterioration diseases. At the same time data have been collected on susceptibility to internal brown spot, on yields and other qualities.

The varieties thus prepared for the investigation have been planted in 1922 on ground infected with the wart disease between rows of a rather susceptible Dutch variety which served as indicator. The experimental plot was situated in the north of the country near the German frontier, which the disease has overlapped. The investigation extended over 33 Dutch, 7 German, 1 English and 2 Swedish varieties. A great difernce in degree of attack was noticed. The varieties which remained free from wart infection were the following of the breeder Veerkamp; Favoriet and Triumph; of the breeder De Vries; Fonteyn, Kruisling and Lieuwe. Also one German variety of the breeder v. Kameke; Pepo remained free from the disease. As regards internal brown spot Favoriet is susceptible, Triumph is resistent, while the three other Dutch wart-resistent varieties are intermediate. These five varieties have all yellow flesh, which is preferred for consumption in Holland. The white fleshed German variety Pepo is considered only good for the starch factories.

Spraying and dusting of potatoes in 1922 at Chatham, Michigan. J. E. KOTILA AND G. H. COONS.

Large plots of Green Mountain potatoes with frequent controls and abundant replications have given results permitting evaluation of various types of foliage treatment. The results are as follows:

TABLE 1.

Potato spraying and dusting tests: Yields for treatment represent averages of 5 plots, the controls an average of 11 plots.

Treatment	Number of applications	Yield in bushels per acre		
		No. 1	Culls	Total
Control		160	40	200
Bordeaux mixture 4–4–50	6	241	43	284
Dehydrated copper sulphate and lime dust	6	192	41	233
Bordeaux mixture 4–4–50—nicotine 1–800	3	199	35	234
Dehydrated copper sulphate and lime plus nicotine 2½ per cent	3	147	38	184

In this field hopperburn and early blight were the disease factors encountered. The differences in yield show the relative efficiencies of the various treatments. It is evident that Bordeaux mixture is far superior to Bordeaux-like dusts, and that its application brings high returns in increased yields.

Hot water and hot air treatments of potatoes. F. M. BLODGETT.

Hot water treatments of mosaic affected Bliss potatoes reported last year were continued with potatoes of the Rural group affected with leaf roll. The results on the killing of Rurals agree so closely with those for Bliss that they may be considered together. The equation given last year of the time-temperature curve for the killing of potatoes has the values of its constant terms slightly changed to fit as nearly as possible all these results and is: $\log_{10}t + .0955\,X = 6.588$ in which t is time in minutes and X is temperature in degrees Centrigrade. This equation is sufficiently accurate to warrant its use as a guide in experimental treatments of potatoes with hot water. All potatoes surviving the treatment still carried leaf roll. Surface injury and decreased sprouting appeared on potatoes treated about half the time required for complete killing. Black heart resulted at all temperatures between 40 and 100° C. in the time range just above that necessary for killing the potatoes. Preliminary experiments with dilute solutions of mercuric chloride produced curves which are parallel to the preceding and slightly below it.

Hot air treatments were tried with white sprout potatoes affected with mosaic. All potatoes surviving the treatment had mosaic. The relation of time and temperature found for killing potatoes by hot air may be expressed by the following equation: $(t - 8.425)(X - 34.5)^3 = 1057000$.

Studies on the causes of stem-end discolorations of potato tubes in North Dakota. WANDA WENIGER.

During the past three years cultural studies of stem-end discolored tubers from nearly every potato growing section of the state have been made with the view of determining the cause and nature of vascular discolorations. The tubers studied were mostly of the Early Ohio variety, all showing a distinct browning of the vascular tissues when cut across about one-fourth to three-eighths of an inch from the point of rhizome attachment. Cultures were made from tissue taken at an average depth of one-half inch from the point of attachment and at least three made from each tuber. Fusarium wilt was found associated with less than one-half of the discolorations, and was not, as is popular belief, the sole cause of discolorations. Many tubers, although showing a distinct browning, gave no growth of any parasitic organism, while others showing little browning gave the Fusarium wilt fungus. In a large percentage of tubers the blackleg bacillus was found, while in some both blackleg and wilt were present. These discolorations, whether yielding growths of Fusarium wilt, of blackleg, of both wilt and blackleg, or of no organism, were not distinguishable either in color or extent.

Ito's potato variety Ekishirazu in New York. DONALD REDDICK.

The potato variety Ekishirazu has been tested in greenhouse and field at Ithaca, New York. In a cool house it grows luxuriantly and produces large tubers. In a warm house it makes very poor growth and produces many small tubers. Both in 1921 and 1922 its growth in the field corresponded to that of the warm house. The variety has been subjected repeatedly, both under glass and out of doors, to extremely

favorable conditions for infection by *Phytophthora infestans*. Occasional small lesions have been produced but conidiophores on lesions of attached leaves have been found only once. The variety substantially bears out its name, "blight unknown," but it is susceptible to mosaic. Under cool conditions the variety produces great quantities of pollen. In conjunction with C. H. Myers, hybrids have been secured with Rural Green Mountain and Evergreen, the latter variety itself possessing marked blight resistance.

The relation of humidity to the infection of sweet potatoes by Rhizopus. J. I. JAURITZEN AND L. L. HARTER

Only a small percentage of potatoes halved with a knife became infected with Rhizopus when subjected to relative humidities of 94 to 98 per cent at temperatures of 22.5 to 24° C.

The percentage of infection increases as the humidity is lowered until at a relative humidity of 72 to 84 per cent it is nearly 100.

At relative humidities of 59 to 63 per cent there is decrease in the percentage of infection and at 49 to 52 per cent it is about 20.

At a temperature of 12° C. the relation of humidity to infection is the same as at 22.5 to 25° C. except that the range is narrower.

If potatoes subjected to humidities of 94 per cent at 22.5 to 25° C. are exposed to lower humidities, scarcely any infection occurs, but if potatoes subjected to humidities of 49 to 63 are placed at the same humidities nearly all become infected.

Apparently changes take place at the higher humidities which make the potatoes more resistant to the attack of Rhizopus. This resistance seems to be located in the outer cells of the cut surface, because if a thin slice is cut off from the potatoes parallel to the cut surface, these potatoes become infected.

The ascigerous stage of the sweet potato black-rot fungus. JOHN A. ELLIOTT.

The fungus known as *Sphaeronema fimbriatum* has been described as having three forms of asexual spores, two of which are borne on free conidiophores and a third in a long-beaked pycnidium. Examination of embedded and sectioned material has shown that the supposed pycnospores are ascospores which are apparently liberated within the perithecium by the early disinitegration of the ascus. The ascospores are produced by free cell formation within the ascus, each ascus at maturity containing, typically, eight spores having a single well-defined nucleus. The perithecia originate in a hyphal knot, arising, at least in some cases, from the intertwining of branches from two distinct hyphal strands. The taxonomic characters place the fungus in the genus Ceratostomella and the specific name *C. fimbriata* com. nov. is therefore proposed for it.

Yellows—Resistant celery: 3rd progress report. G. H. COONS AND RAY NELSON.

Seed production of Golden Self-blanching Celery resistant to yellows (*Fusarium sp.*) was continued on a small scale in 1921 and about a pound of resistant seed is now available for increase. Testing concerned itself with comparing progenies of individual plants for disease resistance. The second generation plants from most isolations possess the same tolerance as the parents and have developed well in infested soil in which commercial seed has failed completely.

Work upon Fusarium—Resistant cabbage in 1922. L. R. JONES, J. C. WALKER AND E. C. TIMS.

The work of the last two summers with disease resistant cabbage has been essentially a continuation of that of preceding years with increasing attention to securing Fusarium resistant strains of certain early varieties. In this the developments promise ultimate success although technical difficulties in holding the early varieties over for seed production have slowed up progress. In addition to established strains of the three later varieties (Hollander, All Seasons, and Brunswick), we have promising resistant strains of the earlier varieties (All Head and Glory).

Further experience has shown the uncertainties associated with depending upon ordinary commercial agencies for maintaining a supply of reliable seed, one such agency having distributed seed this last year which proved to have little resistance. We are, therefore, encouraging two distinct methods for meeting this need. The first is that state men or institutions take the responsibility, probably in cooperation with some state or local growers organization, of securing the resistant strains suited to local needs and growing their own seed either directly or by the contract method. Certain localities and organizations are already doing this successfully. Wisconsin cabbage growing districts have done so for several years and the National Kraut Packers Association grew some 4000 pounds of Wisconsin All Seasons under contract last year for its members. As a second method commercial seedsmen are being advised to hold their seed over one year so as to permit of field trial to determine its disease resistant quality before it is offered for sale.

A new blossom-end decay of watermelons caused by an undescribed species of Pythium. CHARLES DRECHSLER.

At Arlington Farm, Virginia, in 1922, a field disease of watermelons, manifested externally by a dark chocolate-brown or bluish-brown discoloration, that progressed from the blossom region toward the stem end, was decidedly destructive. The rind assumed a watersoaked, candied appearance, while the discolored pulp became flaccid in consistency. The diseased parts were invariably occupied by a fungus closely resembling *Pythium artotrogus* DeBary in size of oogonium and oospore, and in the presence on the oogonial wall of narrowly conical radial processes. However, while in *Pythium artotrogus* fertilization is always accomplished by a "hypogynal" antheridium, in the watermelon parasite it is effected more frequently by multiple branch antheridia, of which from one to four are usually present. The stalk antheridia, moreover, are considerably shorter, their length and diameter being approximately equal. The fungus may occasionally enter the watermelon by wounds or by lesions caused by other fungi. Infection resulted from inoculation with pure cultures under the rind.

The watermelon decay attributable to *Pythium debaryanum* Hesse, which also was abundantly present in the field, is distinguished from the new trouble by light brownish discoloration of the exterior, bleaching of the pulp to pale pink, exfoliation of the epidermis on slight chafing, a peculiar strong marshy odor, and the frequent presence on the moist under-side of extramatrical mycelium.

Seed treatment in the control of pepper diseases. B. B. HIGGINS.

In studying the diseases of pepper which occur in Georgia it has been found that the common leaf spot and fruit rot organisms (*Cercospora capsici* Heald & Wolf, *Bacterium*

sp., *Gloeosporium sp.*, *Colletotrichum sp.*, *Macrosporium sp.*, and *Phoma destructiva* Plow.) may be carried over from year to year on contaminated seed. Since seed contamination is certain where seed are gathered on a commercial scale, efforts are being made to develop a satisfactory method of seed treatment; but the varying response of pepper seed to treatment with disinfectants makes the task difficult. A solution which stimulates germination and subsequent growth at one time may seriously impair germinations of the seed at another. It is hoped that more uniform results may be obtained by treating the fresh seed as they come from the washers. For treating the seed at planting time the best results have been obtained with copper sulphate solution. The seed are soaked in water 6 to 24 hours, drained, soaked 5 minutes in a 1 to 80 copper sulphate solution, dusted with air slacked slime, and planted at once.

An improved formaldehyde tank for the onion drill. A. V. OSMUM AND P. J. ANDERSON.

The only successful method known for controlling onion smut is by the application of formaldehyde in the seed furrow at planting. All investigators have employed essentially the same type of apparatus which has no provision for eliminating variation in rate of application due to reduction of pressure as the column of liquid lowers in the open tank and to speed of operator. To obviate these difficulties a new type of apparatus has been developed at the Massachusetts Agricultural Experiment Station. The chief features of the improved equipment are: (1) a tank made air-tight at the top by a screw-cap, air to replace the liquid being admitted through a stand-pipe attached near the bottom which eliminates variation in rate of flow due to diminishing "head"; (2) changeable discs with graded openings which fit into a union in the delivery pipe regulate the size of the outflow stream to correspond with the rate at which the operator walks. A table based on formulae of application and the time it was found that different operators required to push the drill a certain unit of distance indicates to the operator which of the numbered discs to use. Other improvements of minor importance.

Botrytis rot of the globe artichoke (Cynara scolymus). GEO. K. K. LINK, G. B. RAMSEY AND ALICE A. BAILEY.

Botrytis rot, due to *Botrytis cinerea* (Pers.), causes heavy losses in shipments from California of the globe artichoke.

Although primarily a transit disease it begins in the field where the original contamination and frequently the original infection take place. The fungus was found in the artichoke fields near Half Moon Bay, California. There, favored by heavy fogs and cool weather, the fungus grows and sporulates profusely. Lesions on the growing buds generally are to be ignored in harvesting and packing.

Successful inoculations were obtained by using as inoculum: (1) spore suspension, (2) potato agar cultures, (3) infected bud scales. To get infection by the first method, it was found necessary to saturate the air in the infection chamber with a spray of water once every 24 hours for three to four days. This method probably approximates conditions under which original field and transit infections occur, while the third method is the way in which the disease spreads in transit. The fungus causes very little rot at temperatures above 80° F., and practically none at 0°–2° C., although it grows slightly on agar at 0° C. The rot progresses most rapidly at temperatures between 68 and 75° F., lesions 4–8 mm. in diameter developing within 24 hours after inoculation.

Controlling tobacco wildfire in the seed-bed. P. J. ANDERSON.

On five successive crops of tobacco seedlings in the Experiment Station beds wildfire was reduced to an average of not over one per cent by spraying or dusting the beds with a copper fungicide. The percentage of infection on the controls varied from 20 to 92. Copper lime dust, Bordeaux mixture and various commercial fungicides were all about equally effective. No definite interval between applications can be established, but they must be sufficiently frequent to keep the leaves covered at all times. Dusting is more expensive than spraying but is more rapid and more popular with the growers. Growers who used enough fungicide and applied it frequently enough were successful in keeping the beds clean.

The Sphaerulina leaf spot of clover. E. F. HOPKINS.

This disease which appears not to have been previously reported from America was first observed by the writer in the spring of 1920, on the campus of the University of Missouri. It was later observed in several other places in Missouri, in Illinois and New York. The malady has been noted principally on *Trifolium repens* but *T. hybridum* and *T. pratense* have been found abundantly infected. Inoculation experiments show that *T. pratense perenne* is very susceptible.

Evidence that the disease has been present at Columbia, Missouri, since 1902, was obtained when typical lesions were found on an herbarium specimen, of *T. repens*, collected at that time.

The lesions produced on the leaves are at first very minute, dark spots which usually have at their centers one to several muriform spores. Later the lesions enlarge and are then characterized by a light brown center surrounded by a dark margin. At this stage numerous perithecia appear. A study of these perithecia show the organism to be *Sphaerulina trifolii* E. Rostr. and inoculations made with cultures obtained from young lesions and also from single ascospores proved the organism to be pathogenic. Abundant infections were obtained by exposing healthy plants to leaves bearing perithecia. Lesions found on flower parts indicate that infection of the seed may take place.

The occurrence of zonate eye-spot on various grasses and its mode of extension. CHARLES DRECHSLER.

During the summer of 1922, *Helminthosporium giganteum* H. & W. was prevalent near Washington, D. C., on a number of grasses besides *Cynodon dactylon* L., on which it was originally described. On this host and on *Phalaris arundinacea* L. the fungus exhibited its greatest destructiveness. *Eleusine indica* (L.) Gaertn., *Bromus inermis* Leyss., *Agropyron repens* (*L.*) Beauv., *Agropyron elongatum* Host, *Agropyron intermedium* Beauv., and *Lasiagrostis splendens* Kunth, were severely attacked also. Moderate infections occurred on *Agrostis stolonifera* L.,*Elymus virginicus* L., and *Leersia virginica* Willd. *Pennisetum japonicum* Trin., *Panicum dichotomiflorum* Michx., *Panicum gattingeri* Nash, *Panicum clandestinum* L., *Panicum anceps* Michx., *Eragrostis major* Host, *Eragrostis pectinacea* (Michx.) Nees, *Muhlenbergia mexicana* (L.) Trin., *Muhlenbergia schreberi* Gmel., *Poa pratensis* L. and *Phleum pratense* L., were spotted to a variable extent when growing with more favorable hosts.

The destructiveness of the fungus is largely dependent on heavy dews or moderately prolonged rains, as the parasite, owing apparently to inability to grow any considerable

distance in the mesophyll seems unable under dry conditions to enlarge the relatively small spots resulting from infections by individual conidia. However, when the affected part is moistened externally, a superficial prostrate mycelium arising from the margins of the dead areas is extended centrifugally and infects the surrounding tissue. This intermittent development continues until the entire leaf blade is involved, the discoloration of the dead foliage presenting a strikingly characteristic zonation.

Sulphur as a fungicide. I. Colloidal sulfur. H. C. YOUNG.

Colloidal sulfur was prepared by three different methods, namely, by "The Raffo," by "The Oden," and by a special method. The toxicity of this form of sulfur was determined by using *Colletotricum gossypii, Glomerella cingulata, Gleosporium venetum, Botrytis cinerea, Sclerotinia cinerea, Phomopsis sp., Macrosporium sarcinaeforme,* and *Fusarium oxysporum.* Sulfur in this form is very dilute solutions was found to be very toxic within a narrow limit of hydrogen-ion concentration (about pH 5.8), to all the organisms used. The finer colloidal particles were found to be more toxic, and a general lessening of toxicity was noted as the particles increased in size. Finely divided flowers of sulfur was found to be more toxic than the ordinary flowers of sulfur sold on the market. This toxicity was also influenced by the hydrogen-ion concentration, the point of greatest toxicity being the same as in the case of colloidal sulfur. Changes in the reaction of lime sulfur were also studied. Dilute lime sulfur (1–8) is alkaline beyond the pH range, but changes within a few hours after spraying to pH 6–7.

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